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PLANNING WORKING PAPER NUMBER 83-7

An Analysis of Ground Transportation to
Chicago-O'Hare International Airport

By

David Zavattero, Chief Transportation Planner
and Michael Milillo, Chief Freight Planner

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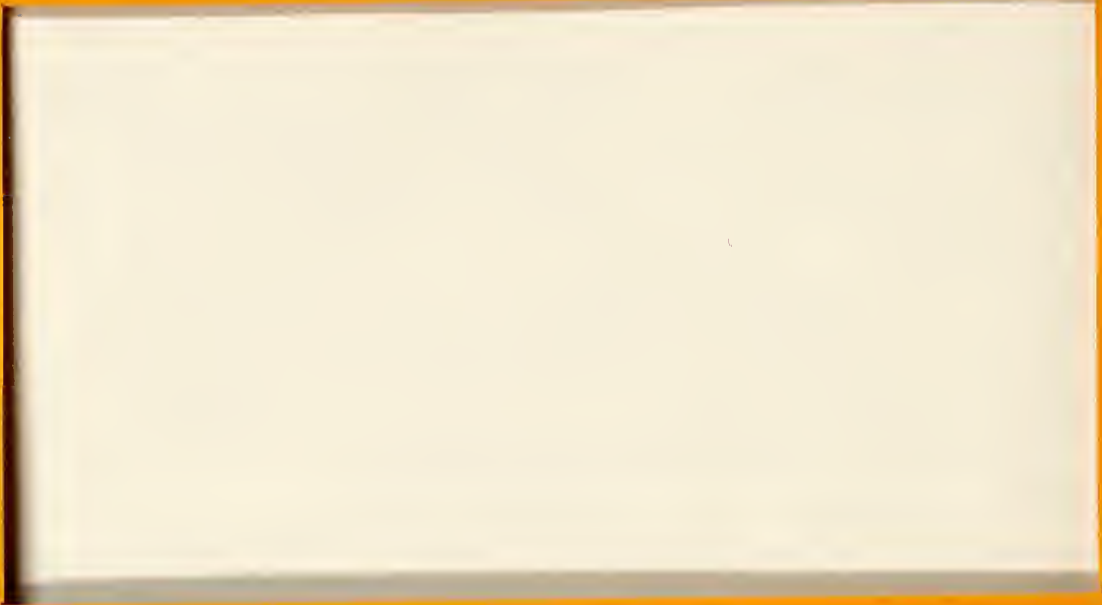
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NORTHWESTERN UNIVERSITY

Chicago Area Transportation Study

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This paper is prepared to document and promote the exchange of technical information and procedures. It represents the opinions and conclusions of the staff and does not represent the policy views of either the Policy or Work Program Committees of the Chicago Area Transportation Study. This report was prepared in part with financial assistance of the U.S. Department of Transportation, Federal Highway Administration, Urban Mass Transportation Administration and the Illinois Department of Transportation. It does not reflect the review or approval of these agencies.



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Introduction

Chicago-O'Hare International Airport connects Chicago and its hinterland to the rest of the country and the world. It is the world's busiest airport and a significant resource for Chicago's economy. O'Hare airport opened in 1959 and quickly replaced Midway as Chicago's major airport. O'Hare was one of the first airports designed for the jet age. By 1961 O'Hare was handling nearly 10 million passengers. Its system of seven runways and its central core of three terminals, more than 95 gates, and over 10,000 parking spaces was well designed to handle a large volume of traffic and it grew rapidly.

By 1978, O'Hare's peak traffic year, the airport was serving over 49 million passengers annually, more than double its original design capacity. The efficiency of the original design allowed the airport to accomodate the amazing growth since opening day. A summary of the level of activity at O'Hare from 1974 to 1981 is given in Table 1. Between 1962 and 1978 aviation traffic at O'Hare grew at an annual rate of 8.5%. Since 1978, however, traffic has declined at O'Hare as it has at most other airports in the United States. This decline is largely attributable to the economic recession. The long term prospects for the aviation industry are good. The Federal Aviation Administration as recently as 1981 was still projecting a long term growth rate at O'Hare of nearly 4% per year between 1980 and 1992 (15).

Table 1 also gives an indication of the mix of traffic. Over 95% of the traffic at O'Hare is carried by the domestic scheduled airlines.

International scheduled carriers account for about 3%, and all non-scheduled

TABLE 1: CHICAGO-O'HARE INTERNATIONAL AIRPORT OPERATIONAL STATISTICS

	<u>1974</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
TOTAL PASSENGERS	37,893,449	49,151,449	47,842,510	43,653,167	37,992,151
TOTAL OPERATIONS	694,674	760,606	735,245	724,155	645,614
SCHEDULED DOMESTIC					
Passengers	35,268,132	46,134,709	44,488,298	40,253,540	34,651,878
Operations	583,626	656,220	614,382	612,512	542,441
SCHEDULED INTERNATIONAL					
Passengers	1,995,330	2,680,408	2,791,844	2,776,332	2,742,058
Operations	25,824	28,265	28,210	27,330	25,340
NON-SCHEDULED ALL					
Passengers	629,987	675,256	526,760	449,841	403,123
Operations	85,224	91,986	92,653	83,756	77,430
FREIGHT (tons)					
Mail	165,605	183,291	166,973	181,145	183,095
Other	719,224	745,611	692,532	670,328	643,359
GROUND ACTIVITY					
Parked cars	3,949,837	4,890,205	4,394,694	3,829,433	3,459,014
ENERGY					
Aircraft fuel (1000 gal.)	760,403	817,369	784,621	743,434	632,253

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carriers about 2% of O'Hare's annual passenger traffic. An additional important point about O'Hare is its' high level of transfer traffic. Chicago has developed over time as a major aviation transfer hub and approximately half of the traffic at O'Hare is connecting.

In part, O'Hare's growth reflects the growth in commercial aviation since the 1950's. In part, it reflects the locational advantages of Chicago as a major hub in the U.S. aviation system. In part, O'Hare's growth represents the enormous population and industrial base of the Chicago region. And in part, it reflects the high level of accessibility provided to the airport by major ground transportation facilities such as the Kennedy Expressway, the Tri-State and Northwest Tollways, and soon the O'Hare transit extension.

O'Hare has recently been challenged by the new Atlanta Hartsfield airport as the world's busiest. Though it's lead over Atlanta is narrowing, O'Hare continues to serve more passengers than any other airport (7). The growth of newer aviation hubs like Atlanta and Dallas has obviously reduced the traffic growth at airports like O'Hare. Both Atlanta and Dallas have recently built new, spacious airports more aptly suited to the larger wide-body jet aircraft now being introduced. In order for O'Hare to continue to provide the aviation services needed to support and promote economic development it must be dramatically redesigned to function efficiently in this new environment.

The O'Hare Airport Master Plan and the Access Study

The City of Chicago began preparation of a new master plan for O'Hare airport in 1974 (see (21) through (23)). The plan focused on the three major constraints limiting O'Hare's capacity to accomodate anticipated future aviation demand. These constraints were identified as: 1) the number and

size of gates, 2) the amount of terminal space, and 3) the ground access and traffic circulation systems supporting the airport. Each of these subsystems is now operating at or near capacity. A key objective of the master plan was to design an airport that could accommodate an anticipated 1995 demand of over 90 million passengers or nearly twice O'Hare's peak traffic load.

The master planning process introduced a variety of concepts to improve O'Hare's capacity, efficiency, and performance. Proposals for additional terminal and gate facilities ranged from expansion of the existing central core to construction of a system of satellite concourses and gates. Proposed ground access improvements included widening of the present entrance roadway, new western and/or northwestern access points, remote parking lots, and an airport people mover system.

This year the O'Hare CTA extension will go into service. This new, high speed, transit link between the Chicago Loop and O'Hare should relieve some of the congestion along the Kennedy expressway and was also incorporated into the master plan.

This paper concentrates exclusively on the question of ground access to this major aviation facility. More specifically, the capacity of the highway system serving O'Hare to handle present and future ground traffic is examined in some detail. In addition, four alternative highway access proposals advanced in the master plan (25),(26),(27) are tested against likely future demand.

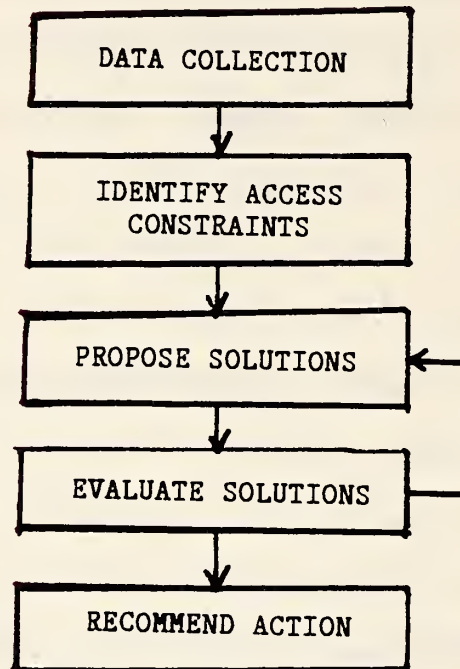
Obviously airside and landside facility development on the field itself will have important implications for regional ground access to O'Hare. The access analysis was structured to consider these interactions and was closely coordinated with other aspects of the master plan. The analysis was conducted

by the Chicago Area Transportation Study (CATS) to evaluate the access alternatives proposed during the O'Hare master plan development. While none of the tested access alternatives exactly duplicates the O'Hare development plan eventually recommended (25), the insights gained through the access study were felt to be helpful in formulating the final design.

The O'Hare access study was organized and conducted as a conventional urban transportation planning process and involved the major steps of problem definition, inventories, modeling, and development and evaluation of alternatives. The airport access planning process is summarized in Figure 1. Both existing and future access conditions were examined. Present bottlenecks and congestion problems were identified. The year 1975 was taken as the base and 2000 as the forecast period for the analysis. The base year analysis and the deficiency analysis of the future demand on existing facilities was used to develop a set of design concepts for future access systems. These concepts were then operationalized as highway networks. Estimated future demand was loaded onto the alternative future networks to determine their relative performance characteristics. This information was used in the master plan process to define desirable features of the recommended access system.

A technical advisory committee was established to conduct the study. Effort was made to coordinate the ground access study with the master plan process through participation of the Chicago departments responsible for operating and planning O'Hare as well as the consultants involved in plan preparation. The O'Hare Advisory Committee included staff representation from the CATS, the Chicago Department of Aviation, the Chicago Department of Public Works, the Illinois Department of Transportation, the Illinois Division of Aeronautics, the Regional Transportation Authority, the Chicago Transit

FIGURE 1: THE AIRPORT ACCESS PLANNING PROCESS



Authority, the DuPage County Regional Planning Commission, Landrum and Brown, and O'Hare Associates. This broad participation in the access study clearly indicates the importance of the ground access system as well as its role in the master plan.

The Airport Access Problem

Airport access, particularly around close in airports like O'Hare, has been identified as a potential threat to aviation growth and an important constraint on the advantages of air travel. Forecasts of access conditions at major U.S. airports (13) indicate that the situation will worsen unless corrective actions are taken. These actions may range from lower cost traffic management improvements to large scale investments in new facilities. Obviously, the appropriate type of solution and level of investment depends on the problems surrounding the specific airport.

Several writers have discussed the general nature of the airport access problem (2), (10), (11), (19), (28). They conclude that airport planning has tended to ignore the access question by concentrating their analysis on the field itself. Where access is considered it is usually done by looking at the circulation of traffic within the confines of the airport property. While this is an important consideration the larger question of regional access to the airport must also be taken into account.

The advantage of air travel in faster line haul times can be significantly reduced if the trip to the airport encounters heavy congestion and delay. In fact, two studies have examined the impact of access time and cost on air travel demand (3), (33). Continued growth in air travel assumes that the airport access problem will be addressed and solved in the next decade. Cities

such as Chicago and Washington have invested heavily in providing high speed transit links between their airports and CBD's. Other less costly solutions have been suggested (12), (16) for improving access time to airports. These lower cost transportation systems management solutions include: traffic operations improvements such as signalization, channelization, and reversible lanes; preferential treatment of high occupancy vehicles such as freeway diamond lanes and park-and-ride facilities; and reducing vehicle use through carpooling and pricing. The present access study focuses on the longer term, more capital intensive solutions to major highway deficiencies. Once an appropriate capital program is developed and implemented it is anticipated that future efforts will examine transportation system management alternatives to obtain the most efficient use of the access system serving O'Hare.

Existing Ground Access to O'Hare

O'Hare is located approximately 17 miles from the Chicago Loop. The airport lies on over 6,900 acres in both Cook and Dupage counties and is served by a number of major ground transportation facilities as shown in Figure 2. Those ground facilities within a three mile radius of the airport are shown in Figure 3.

The major access route to O'Hare from the east is the Kennedy Expressway (interstate route I-90). This is an eight lane, limited access highway providing direct auto access to the Chicago Central Business District (CBD). The Eisenhower Expressway (I-290) is also an eight lane, limited access highway providing additional access from the CBD via the Tri-State Tollway. The Tri-State Tollway (I-294) is a limited access toll facility providing access to O'Hare from the north and south. Access from the northwest is

FIGURE 2: LOCATION OF O'HARE AIRPORT IN CHICAGO SMSA

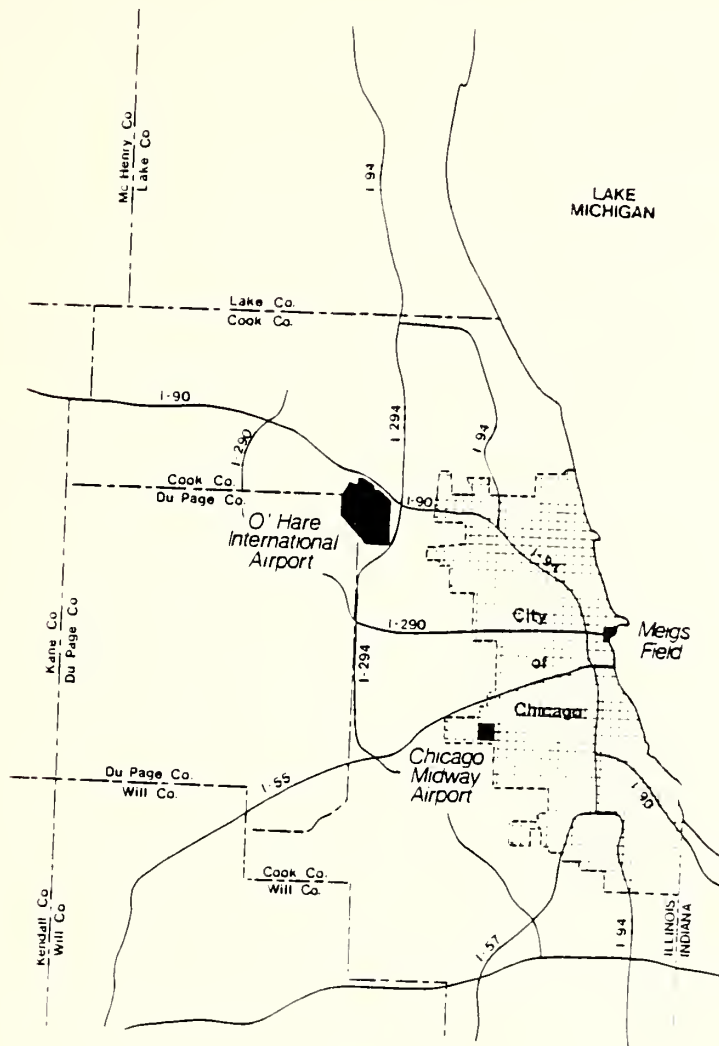
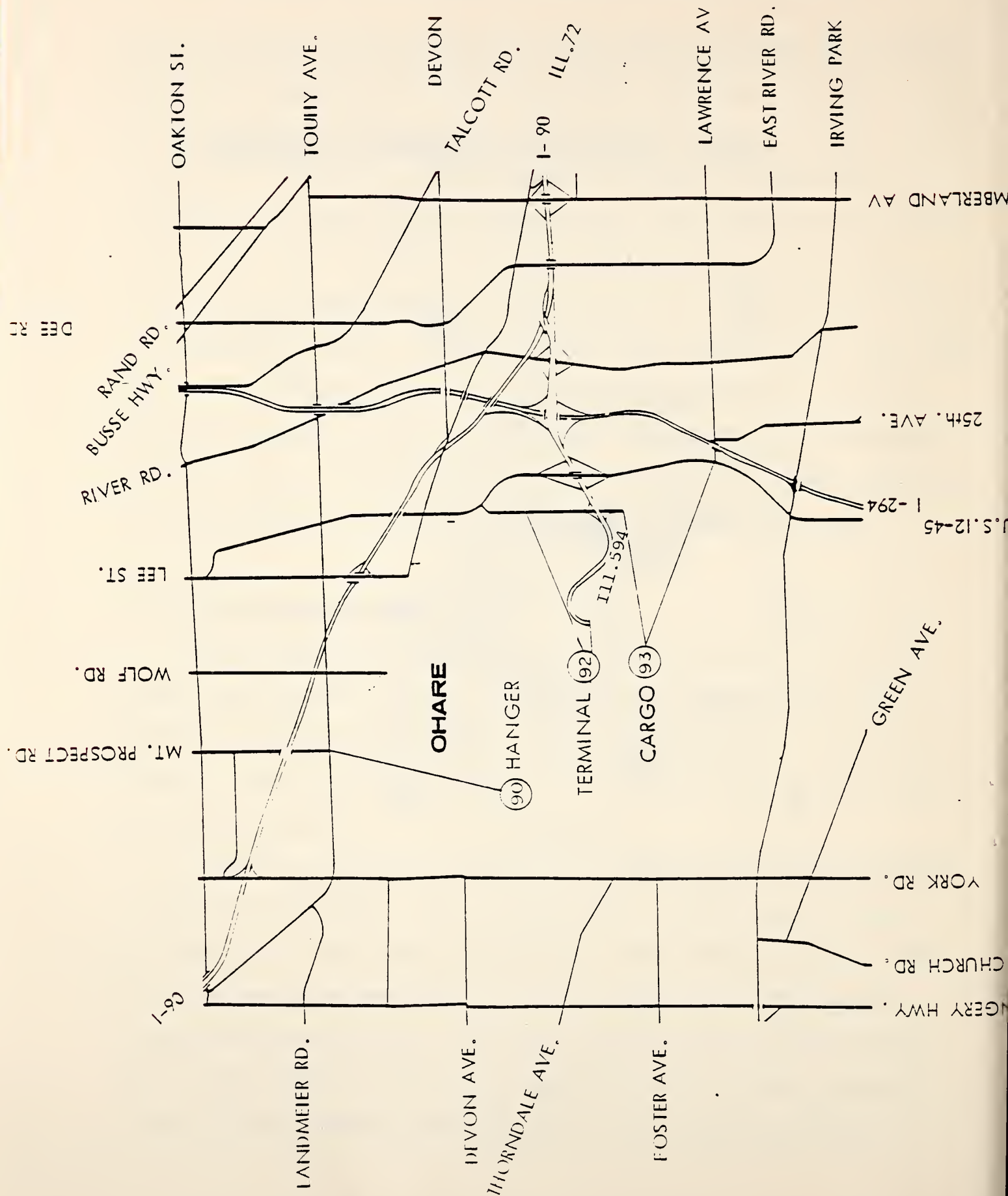


FIGURE 3: O'HARE AIRPORT SURROUNDING HIGHWAY FACILITIES



provided by the Northwest Tollway (I-90) which intersects with the Tri-State and the Kennedy just northeast of the airport. Southwest access is provided by the East-West Tollway (Ill-5) a six lane, limited access toll highway connecting with the Tri-State Tollway.

Mannheim Road (US-12 and US-45) is a four lane divided arterial providing secondary north-south access on the eastern side of the field. York Road is a two to four lane north-south arterial running along the western side of O'Hare. Touhy Avenue and Higgins Road are the main arterials providing east-west access to the north of the airport. Irving Park Road is a divided four lane arterial on the airport's southern boundary.

The principal entrance to the airport for all passengers and visitors and for the majority of employees is Illinois 594 which intersects with the Kennedy Expressway about 1 1/2 miles east and with the Tri-State about 1/4 miles east of the airport. This main entrance roadway is a limited access facility varying from four to six lanes and is the only direct access to the terminal and gate complex. The terminals are served by a two-level loop roadway with three lanes on each level. The upper level is used for departures and the lower level for arrivals.

In addition to providing direct access to the terminals the airport entrance roadway (Ill-594) provides access to the parking garage and lots. The parking facilities at O'Hare consist of a multi-level garage with an adjacent ground level lot in the central core and a remote annex lot for longer term parking located off Old Mannheim Road. A shuttle bus service carries passengers and employees from the remote lot to the terminals.

O'Hare's hanger and aircraft maintenance facilities are located in the northwest corner of the field and are accessible via Mount Prospect Road and

Touhy Avenue. The large cargo complex is located in the southeastern corner and can be accessed either by Old Mannheim Road or Lawrence Avenue.

Of course, these highway facilities are also used by the public and private bus operators serving O'Hare. In addition a large number of passengers arrive and depart O'Hare via taxis or rental cars. Several private bus and limousine companies carry passengers to O'Hare. Largest of these is Continental Air Transport which provides scheduled, direct bus service to the airport from the Chicago Loop and several suburban locations. Numerous smaller bus and limosine operators provide scheduled service to O'Hare from points as remote as South Bend, Indiana.

The CATS Year 2000 Transportation System Development Plan (6) recommends two major additions to the highway system which will affect airport access. The proposed Elgin-O'Hare Expressway would add substantial western access capacity. And, the Illinois 53 extension south to I-80 would divert some non-airport traffic from the Tri-State thereby improving flow along this facility. And finally, as has been noted, the CTA O'Hare extension will expand rail transit service at the airport.

Present Use of the Ground Access System

In this section some characteristics of the current users and the use of the existing ground access system are examined. Surveys of passengers and employees at O'Hare were conducted at an early stage in the master plan process (8). Surveys were distributed to passengers as they boarded flights at O'Hare during several weeks in the summer of 1977. Originating passengers were asked to provide information on trip purpose, ground trip origin, mode of arrival at the airport, parking, persons accompanying, family income, and home

and office zip codes. Airport and airline employees were asked to indicate their on field work location, arrival and departure times, mode, home zip code, and, for flight crews, some information on the frequency of flights worked out of O'Hare by day of the week. As will be described in a later section, these data were used in the access study to estimate airport related ground traffic.

Some summaries of the passenger survey responses are given in Tables 2 through 5. These tables include only those passengers whose trip originated at O'Hare since the concern was with access issues. Table 2 differentiates passengers by trip purpose and family income. Recreation and business purposes each account for over 40% of the passenger trips from O'Hare. The family income distribution shown in Table 2 indicates that air travel continues to attract a larger share of middle and upper income users.

Roughly half of the originating travelers at O'Hare are permanent Chicago area residents as seen in Table 3. Further, the majority of ground trips to O'Hare begin at the passengers regular residence. Hotels and motels account for almost 17% and business or employment locations over 13% of ground trip origins. Finally, also from Table 3, nearly two-thirds of all passengers arrive at O'Hare unaccompanied. At the other extreme, nearly 10% of the passengers are accompanied by three or more visitors.

The arrival mode of originating passengers at O'Hare is summarized in Table 4 by ground trip origin location within the region. The automobile is the primary access mode for passenger trips to and from O'Hare airport. About 63% of all such trips to O'Hare are by private auto. In contrast, only 11% are by taxi, 10% by transit bus, 9% by limosine, airport bus, or courtesy car, and 7% by rental car. Of course, as seen in Table 4, these mode split

TABLE 2: O'HARE 1977 PASSENGER SURVEY, AIR TRIP BY PURPOSE AND INCOME

	<u>Number of responses</u>	<u>Percent</u>
BY PURPOSE		
Recreation	2588	42.1
Business	2520	41.0
Convention	368	6.0
Personal	199	3.2
School	140	2.3
Military	56	0.9
Other	282	<u>4.6</u>
No response	<u>185</u>	100.0
	6338	
BY ANNUAL FAMILY INCOME (1977)		
Under \$15,000	960	18.9
\$15 to \$25,000	1221	24.0
\$25 to \$35,000	1100	21.6
\$35 to \$50,000	884	17.3
Over \$50,000	934	<u>18.3</u>
No response	<u>1230</u>	100.0
	6329	

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TABLE 3: O'HARE 1977 PASSENGER SURVEY, CHICAGO RESIDENT,
GROUND TRIP ORIGIN, AND PERSONS ACCOMPANYING

	Number of responses	Percent
CHICAGO AREA RESIDENT?		
Yes	2963	50.2
No	2942	<u>49.8</u>
No response	<u>425</u>	100.0
	6330	
BY ORIGIN OF GROUND TRIP TO O'HARE		
Regular residence	3204	51.7
Hotel, motel	1047	16.9
Other residence	881	14.2
Other business	441	7.1
Reg employment	378	6.1
College	65	1.0
Military	38	0.6
Other	145	<u>2.3</u>
No response	<u>138</u>	100.0
	6337	
BY NUMBER OF PERSONS ACCOMPANYING		
None	4125	66.9
One	865	14.0
Two	572	9.3
Three or more	602	<u>9.8</u>
No response	<u>170</u>	100.0
	6334	

TABLE 4: O'HARE 1977 PASSENGER SURVEY, MODE CHOICE

	Ground trip location					
				All		
	<u>CBD</u>	<u>City</u>	<u>Suburbs</u>	<u>Else</u>	<u>Total</u>	<u>Percent</u>
BY MODE						
Auto, drive	26	234	688	49	997	20.3
Auto, passenger	31	621	1350	112	2114	43.0
Taxi	83	331	122	1	537	10.9
Airport, public bus	73	193	81	69	416	8.5
Transit with bus	6	23	7	2	38	0.8
Rental car	11	62	139	49	261	5.3
Suburb limo	4	25	188	23	240	4.9
Courtesy car, van	3	100	78	1	182	3.7
Other	<u>8</u>	<u>80</u>	<u>34</u>	<u>11</u>	<u>133</u>	<u>2.7</u>
Total	245	1669	2687	317	4918	100.0
Percent	5.0	33.9	54.6	3.9	100.0	

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TABLE 5: O'HARE 1977 PASSENGER SURVEY, USE OF CTA EXTENSION

	<u>Number of responses</u>	<u>Percent</u>
WOULD USE CTA O'HARE EXTENSION?		
Yes	2294	40.9
No	1841	32.8
Not sure	1470	<u>26.2</u>
No response	<u>730</u>	100.0
	6335	

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percentages vary significantly by geographic area. Taxi access is heavily oriented to the CBD, accounting for about a third of all such trips. Alternatively, the private auto carries slightly over three fourths of the access trips from suburban locations.

Table 5 summarizes the response of originating passengers to a hypothetical question concerning the likely use of the new CTA O'Hare extension. Travelers were asked if they would use the extension when it opened. The response was extremely positive indicating that as many as 40% of the present passengers would use the transit service. This alternative is directly feasible (without transferring) for the CBD and a fraction of the city trips. Given the relatively high time preference of the typical air passenger it was felt that this response probably overstated the potential of the line to attract riders from other modes.

Detailed case studies of access around several large hub airports are presented in (17). O'Hare is one of the airports studied. The analysis concludes that the roadways serving O'Hare currently have moderate to severe access problems. Feasibility studies of several proposals to improve access to O'Hare are recommended.

Most of the major access facilities to O'Hare are currently operating near capacity but at acceptable service levels. The primary exception being the Kennedy Expressway which is heavily congested particularly during peak hours. About 40% of all airport bound trips use the Kennedy making any congestion there a significant problem for O'Hare access. Continued growth in both airport and non airport related traffic will further worsen congestion along this important access route.

Alternative Future Aviation Scenarios

A key step in developing the master plan concepts including access alternatives was the estimation of future air passenger demand at O'Hare. The measure of air passenger activity used for this purpose is annual enplanements. The relationship between these enplanements and the previously reported annual total passengers is shown schematically in Figure 4. Total passengers include originating, enplaning connecting, deplaning connecting, terminating, and through passengers. Traffic at O'Hare is split roughly equally between originating and terminating passengers. As noted, approximately 48% of all traffic at O'Hare is connecting, that is passengers switching planes to get to their ultimate destinations. Through passengers, like connecting passengers, are those for whom O'Hare is also only an intermediate stop. But, unlike connecting passengers, through passengers remain aboard the same aircraft as their flight continues. Only the originating and terminating passengers will utilize the ground access system in getting to or from O'Hare. The other categories of passengers are not likely to leave the airfield and therefore are not considered in the access analysis.

The air travel demand forecasts developed for the entire Chicago hub as part of the master planning process are summarized in Table 6 and described in detail in (21). Based on available data it was assumed that over 92% of future air traffic at O'Hare would be on domestic scheduled flights. These forecasts were prepared in 1976 and have subsequently been revised downward slightly. When they were originally made these forecast enplanements were consistent with the national aviation demand forecasts. They represented the Chicago hub's long term market share of around 10% of total U.S.

FIGURE 4: AVIATION PASSENGER DEFINITIONS

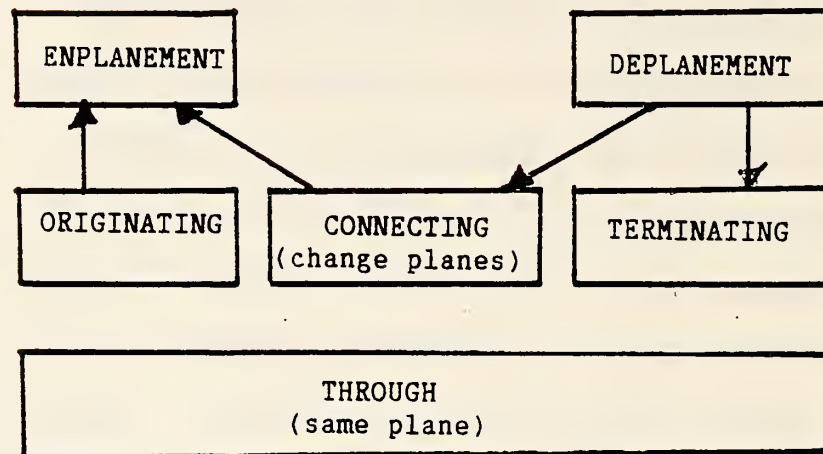


TABLE 6: ENPLANED PASSENGER FORECASTS FOR THE
CHICAGO AIR CARRIER HUB

	Enplaned passengers (1,000's)				
	1974 (actual)	1980	1985	1990	1995
OPTIMISTIC					
SCHEDULED DOMESTIC	16,183	20,810	27,327	34,423	42,604
SCHED INTERNATIONAL	996	1,430	1,956	2,613	3,399
NON SCHED ALL	425	707	1,081	1,523	2,057
TOTAL	17,604	22,947	30,364	38,559	48,060
PESSIMISTIC					
SCHEDULED DOMESTIC	16,183	18,556	23,644	29,056	36,646
SCHED INTERNATIONAL	996	1,214	1,605	2,078	2,765
NON SCHED ALL	425	625	929	1,276	1,755
TOTAL	17,604	20,395	26,178	32,410	41,186

enplanements. At the time of the access study these were the only available forecasts. Therefore, the access demand estimates are based on the aviation levels anticipated in Table 6.

The aviation demand forecasts were based on the following factors: 1.) the population of the market area, 2.) the personal income of that population, and 3.) the relative price of air travel. The Chicago hub market area was defined as the six counties of northeastern Illinois. Six county population was projected to increase from 6.9 million in 1974 to about 8.6 million in 1995. Recent projections by the Northeastern Illinois Planning Commission indicate that a year 2000 six county population of around 8 million is more likely implying that the aviation forecast market population is somewhat overestimated. The regions per capita income was projected to increase by 75% in real dollars in the same twenty year period. The relative cost of air travel was assumed to decline slightly in the aviation forecasts.

As shown in Table 6 both an optimistic and a pessimistic forecast of aviation activity was prepared. The optimistic forecast is based on reasonably stable growth in the aviation industry, a long term growth rate of between 3 and 4% in real GNP, increased real energy costs but without major supply disruptions, and larger, more fuel efficient aircraft with higher payloads. On the other hand the pessimistic forecast assumed sharp increases in the cost of aviation fuel and in air fares.

Master plan concepts were then developed for O'Hare based on four alternative scenarios for accomodating these levels of aviation demand in the Chicago hub. These scenarios represent different assumptions about the share of traffic that might be handled by Midway airport and are summarized in Table 7. Midway is the only other air carrier category airport in the Chicago

TABLE 7: CHICAGO HUB AIR CARRIER DEVELOPMENT SCENARIOS

SCENARIO 0 DO NOTHING

1. Some aviation demand unsatisfied.
2. No expansion at either O'Hare or Midway.
3. Some traffic shifts to other hubs.

SCENARIO 1 O'HARE DEVELOPMENT

1. O'Hare development to meet unconstrained demand.
2. Midway remains general aviation reliever.

SCENARIO 2 O'HARE AND MIDWAY DEVELOPMENT

1. Unconstrained development at O'Hare.
2. Some improvements at Midway.
3. Midway attracts up to 29% of short haul, local O/D traffic.

SCENARIO 3 REVITALIZED MIDWAY

1. Major expansion at Midway.
2. Midway attracts over 40% of short haul, local O/D traffic.
3. Constrained development at O'Hare.

hub. It was felt to be unrealistic to assume the existence of any new, third major airport in the region. In each case the underlying premise was that Chicago should make all practical effort to maintain its traditional share of the national aviation market. In other words, each of the four scenarios described in Table 7 are based on satisfying all of the forecast aviation demand either at O'Hare or at a revitalized Midway airport. Of course, it was recognized that because of its size and its limited runway length Midway could only be considered feasible for locally originating or destined short-haul air trips (that is, trips within an 800-1,000 mile radius of Chicago).

The access study is based on scenario 1, that is it was assumed that O'Hare would continue to function as the primary air carrier airport in the Chicago hub with Midway acting mainly as a general aviation reliever. Having established the level of aviation activity in the base and forecast periods it was necessary to develop estimates of on airport employment. Nearly 25,000 persons were employed at O'Hare in 1975. Based on future air traffic levels, total employment at O'Hare in the year 2000 was expected to be nearly 39,000. The enplaned passenger and employment forecasts used in the access study are given in Table 8.

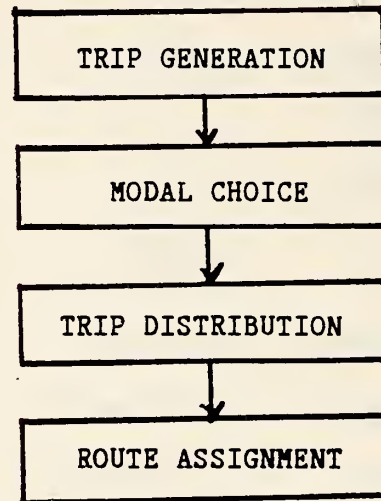
The Access Study Methodology

The enplaned passenger and employment measures of airport activity next had to be converted into average daily trips to and from O'Hare. This was accomplished with the conventional urban transportation demand models as used by CATS (5), (29) and involving the sequence of trip generation, mode choice, and trip distribution as shown in Figure 5. The end result of this process is a set of triptables for each mode which quantify the trip frequency, mode, and

TABLE 8: O'HARE AIRPORT ACCESS STUDY BASE AND FORECAST
ANNUAL ENPLANED PASSENGERS AND ON FIELD EMPLOYMENT

<u>Year</u>	<u>Airport Area</u>	<u>Enplaned Passengers (1,000's)</u>	<u>Employment</u>
1975	TERMINAL	18,493	13,859
	HANGER	0	3,357
	CARGO	0	6,858
	ALL	18,493	24,075
2000	TERMINAL	48,060	22,858
	HANGER	0	5,521
	CARGO	0	10,307
	ALL	48,060	38,687

FIGURE 5: THE CONVENTIONAL URBAN TRANSPORTATION
PLANNING SEQUENTIAL DEMAND MODELS



destination decisions of many individuals. Separate triptables were prepared for work, passenger and visitor, and truck trips to and from O'Hare. These triptables were loaded onto either existing or alternative future highway networks.

For the purposes of the access analysis the traffic on the ground transportation facilities around O'Hare was divided into airport and non-airport related traffic. Obviously, for most of these facilities the majority of traffic will not be directly tied to the airport (see Appendix Figure A4 for a summary of O'Hare's share of volume on selected links). Only those facilities on or immediately surrounding the field will have a preponderance of airport traffic. The ground access study assumes that this non-airport traffic is independent of airport development and aviation activity at O'Hare. Therefore, the non-airport related trips were taken from the 1975 and 2000 triptables previously developed for the Year 2000 Plan. This meant that available triptables could be used. Trips with either origin or destination at O'Hare were reestimated and the available triptables were modified accordingly.

The airport was divided into three major functional areas for the access study. These areas are: the terminal complex; the hanger area; and the cargo area. Figure 3 shows the locations of each area with zones 90, 92, and 93 being the hanger, terminal, and cargo areas respectively. Airport related trips are further defined as being either employee or passenger and visitor traffic. Obviously, the type of use and access needs of each functional area are different. The terminal zone attracts all of the passenger and visitor trips and more than half of the employee trips. The cargo zone attracts some employee trips and most of the truck trips. The hanger zone attracts about

25% of the employee trips. The magnitude of traffic to each of these zones is directly related to airport development and activity.

The trip generation procedure used to estimate daily person trips produced by and attracted to O'Hare was straightforward. The typical weekday was taken as the appropriate time frame for the access study. Daily work trips were estimated by applying an assumed absentee rate of between 10 and 12% to airport employment. Daily passenger trips to the airport were based on enplanements. Average daily enplanements were calculated from the annual numbers using 365 days per year. Half of these daily enplanements were assumed to be connecting passengers who would not use the access system. Therefore originating daily enplanements were estimated by multiplying the total daily enplanements by one half. The O'Hare passenger survey data indicated that the typical passenger was accompanied to the airport by 0.85 visitors. Thus, total passenger and visitor daily person trips were approximated by multiplying daily originating enplanements by 1.85. The total daily person trips for the base and forecast years that resulted from these assumptions are given in Table 9.

Following the trip generation calculation a combined mode choice and trip distribution was performed based on the O'Hare passenger survey data. Arrival mode and ground trip origin location by zip code was available from the survey. Mode splits were seen to vary significantly by location. The survey modes were redefined into three major categories for this analysis. The auto mode was taken as auto driver, auto passenger, and rental car. Taxi was redefined to include suburban limosines and hotel courtesy vehicles. The public transit mode included airport, charter, and public bus as well as rapid transit. The taxi mode was assumed to be available only for passenger and

TABLE 9: O'HARE AIRPORT ACCESS STUDY
BASE AND FORECAST DAILY PERSON TRIPS

Year	Trip Type	Airport Area	Daily Person Trips	Mode Split		
				% Auto	% Public	% Taxi
1975	EMPLOYEE	TERMINAL	12,564	93.8	6.2	
		HANGER	2,563	98.2	1.8	
		CARGO	5,960	93.8	6.2	
		TOTAL WORK	21,087			
	PASSENGER & VISITOR	TERMINAL	50,391	70.3	10.2	19.5
2000	EMPLOYEE	TERMINAL	20,747	95.6	4.4	
		HANGER	4,474	99.1	0.9	
		CARGO	9,062	95.7	4.3	
		ALL AREAS	34,283			
	PASSENGER & VISITOR	TERMINAL	106,198	71.4	9.5	18.9

visitor trips since the survey indicated very little use of this mode by employees.

The regionwide mode split percentages used in this analysis are also given in Table 9. Again, it should be emphasized that the modal shares for each zone in the triptables varied by geographic location of the trip origin. For the year 2000 the mode split shown in Table 9 was adjusted to account for the opening of the CTA extension to O'Hare. This adjustment was performed using the mode choice analysis for the Year 2000 Plan alternative which included this new transit service and resulted in an additional 6,000 employee trips shifting to the new O'Hare rail transit service.

The trip distribution patterns for passengers and employees are summarized in Figures 6 and 7 respectively. These figures show the percentage of O'Hare trips associated with each of the approximately 130 townships in the region and are taken directly from the survey data. Trip ends were allocated to the smaller CATS traffic zones within each township based on the zone's share of the township's population. The region is divided into 1,814 such traffic zones. This method was used for all townships except the CBD and the area immediately surrounding O'Hare. The allocation for these special cases was performed on the basis of the zone's share of hotel rooms.

The next step in the creation of the work and non-work triptables was the conversion from these 1,814 zones to the 459 O'Hare study zones shown in Figure 8. The O'Hare zones were structured to include the greatest zonal and network detail in the four townships nearest the airport. This is the immediate area of concern and the expense of network assignment can be substantially reduced through such a windowing procedure.

Finally, observed vehicle occupancy factors of 1.21 persons per auto for

FIGURE 6: O'HARE PASSENGER TRIP DISTRIBUTION PATTERN

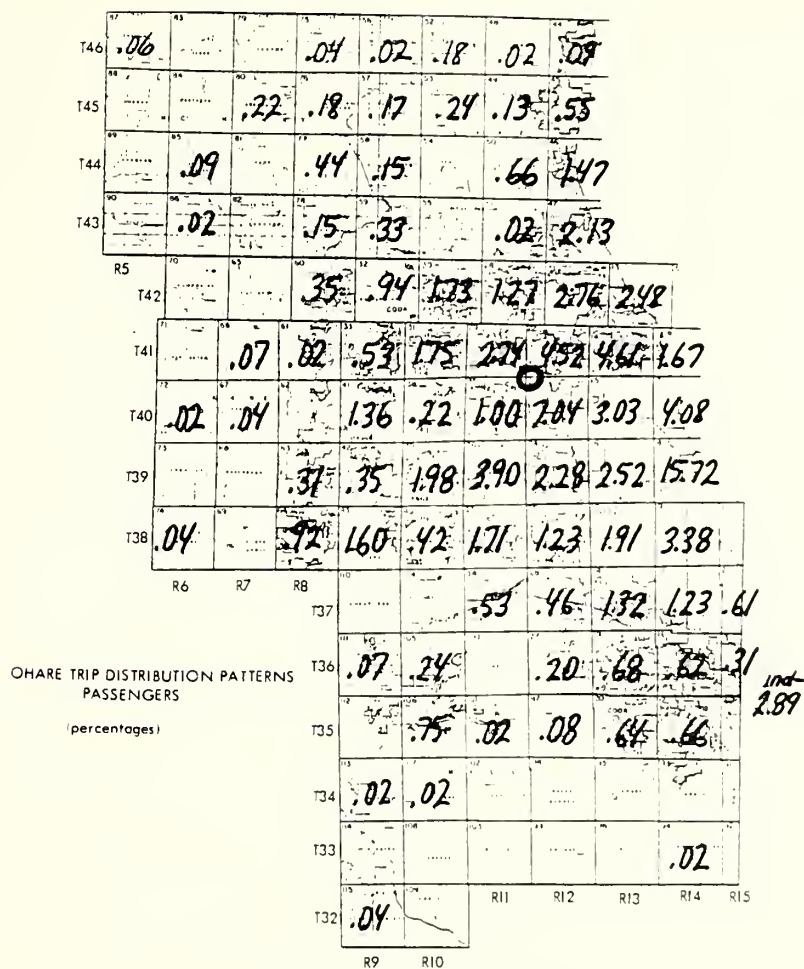
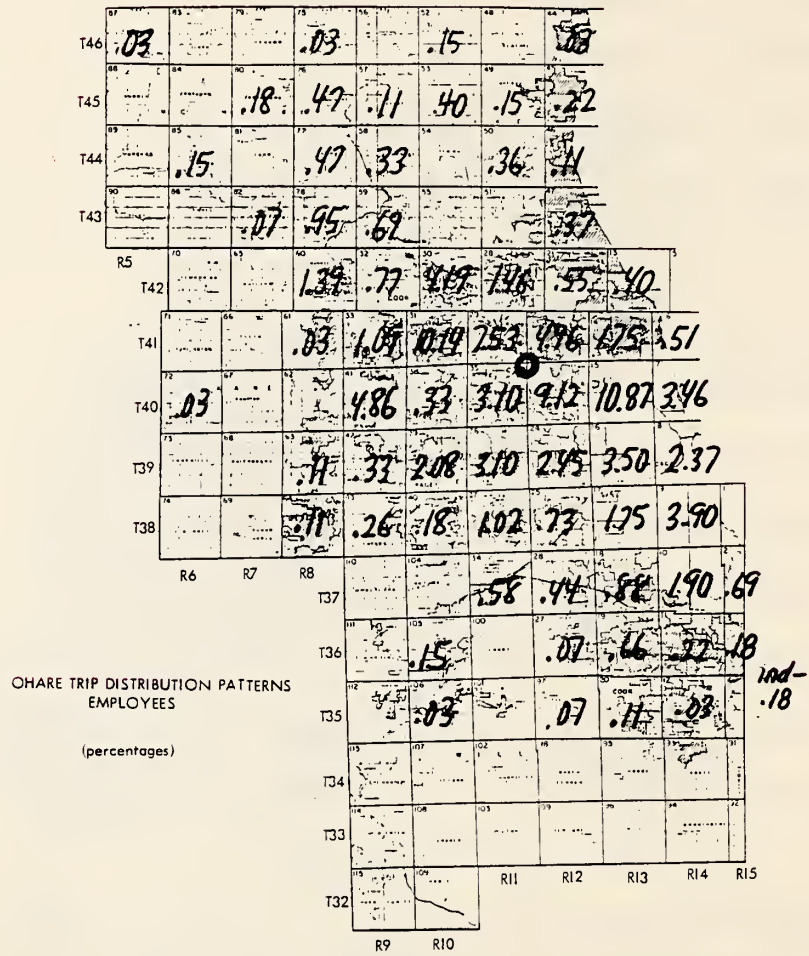


FIGURE 7: O'HARE EMPLOYEE TRIP DISTRIBUTION PATTERN



OHARE ACCESS STUDY ZONES

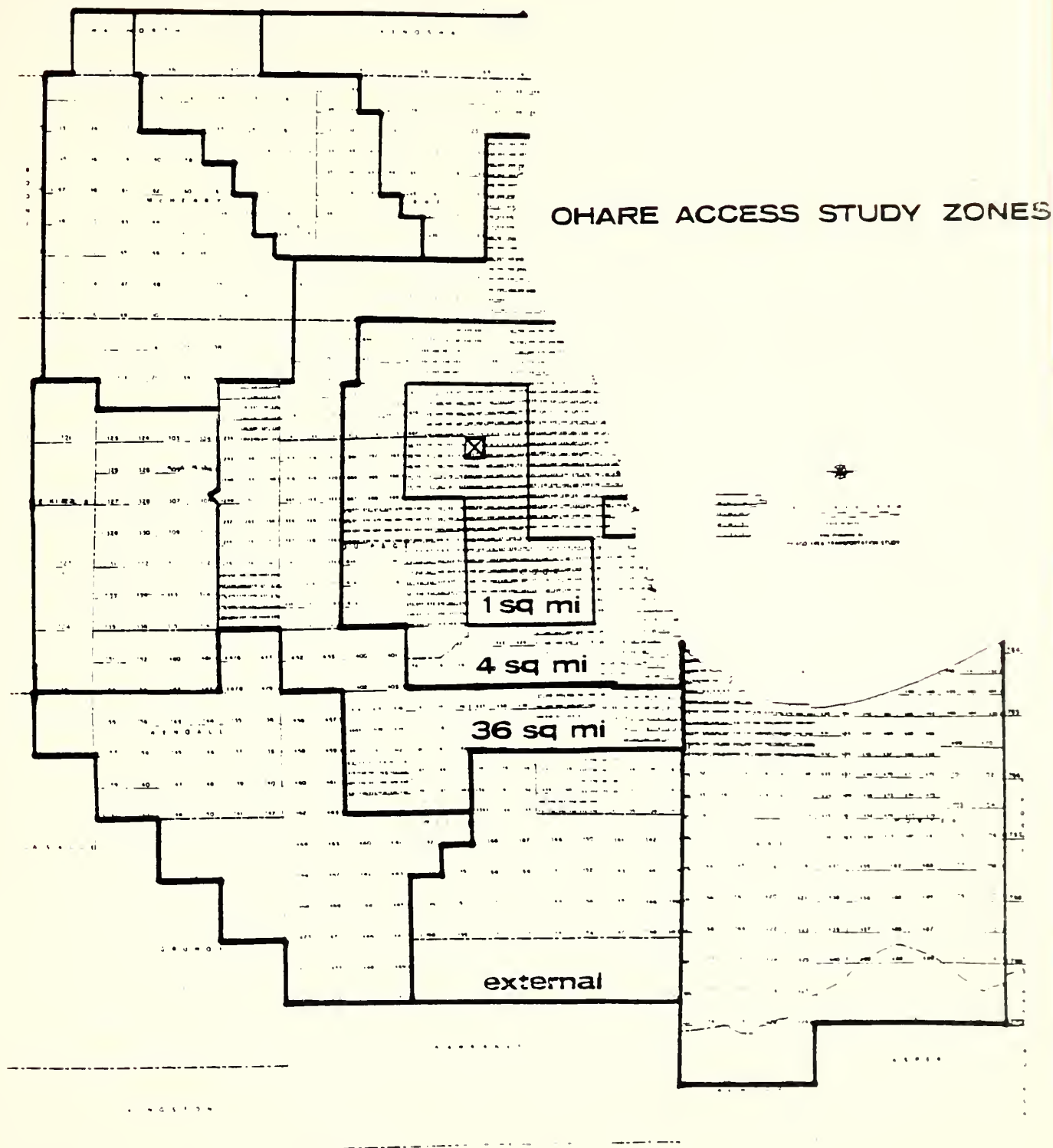


TABLE 10: O'HARE AIRPORT ACCESS STUDY BASE AND FORECAST
DAILY AIRPORT VEHICLE TRIPS

<u>Year</u>	<u>Airport Area</u>	<u>Employee Trips</u>	<u>Passenger & Visitor Trips</u>	<u>Truck Trips</u>
1975	TERMINAL	10,312	24,651	169
	HANGER	2,498	0	169
	CARGO	5,103	0	3,042
	ALL	17,913	24,651	3,380
2000	TERMINAL	17,008	63,814	797
	HANGER	4,108	0	800
	CARGO	7,669	0	14,796
	ALL	28,785	63,814	16,393

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work trips and 1.54 persons per auto for non-work trips were applied to the estimated person trips to obtain daily vehicle trips. Truck trips for this study were taken from the available Year 2000 Plan triptables. The results of the travel demand process are summarized in Table 10 which gives employee, passenger and visitor, and truck trips for each functional area for both the base and forecast years.

Capacity Deficiency Analysis of the Existing Highway System and Development of Alternatives

The demand for access to O'Hare as well as all demand for non-airport related travel for both the base and forecast years are contained in the appropriate triptables. The capacity of the existing highway system serving O'Hare to accomodate this demand was evaluated in the network assignment phase of the access study. These trip demands were loaded on to the existing highway network. Separate assignments were performed for 1975 and for the year 2000. The resulting route choices are based on minimum travel times and costs. The associated average daily link volumes were then compared with the link's capacity. Capacity was defined at level of service "E" which represents somewhat congested conditions and speeds well below posted limits.

The results of this capacity deficiency analysis of the existing system are summarized graphically in Figures 9 and 10 for 1975 and 2000 respectively (Appendix Figure A1 gives the Year 2000 assignment volumes). Figure 9 shows the capacity deficiencies for the highways in the vicinity of O'Hare when 1975 demands are loaded onto the existing system. No severe congestion problems were indicated. There were some minor capacity problems on segments of Mannheim Road and Lee Street.

FIGURE 9: O'HARE ACCESS CAPACITY DEFICIENCY 1975 ON EXISTING

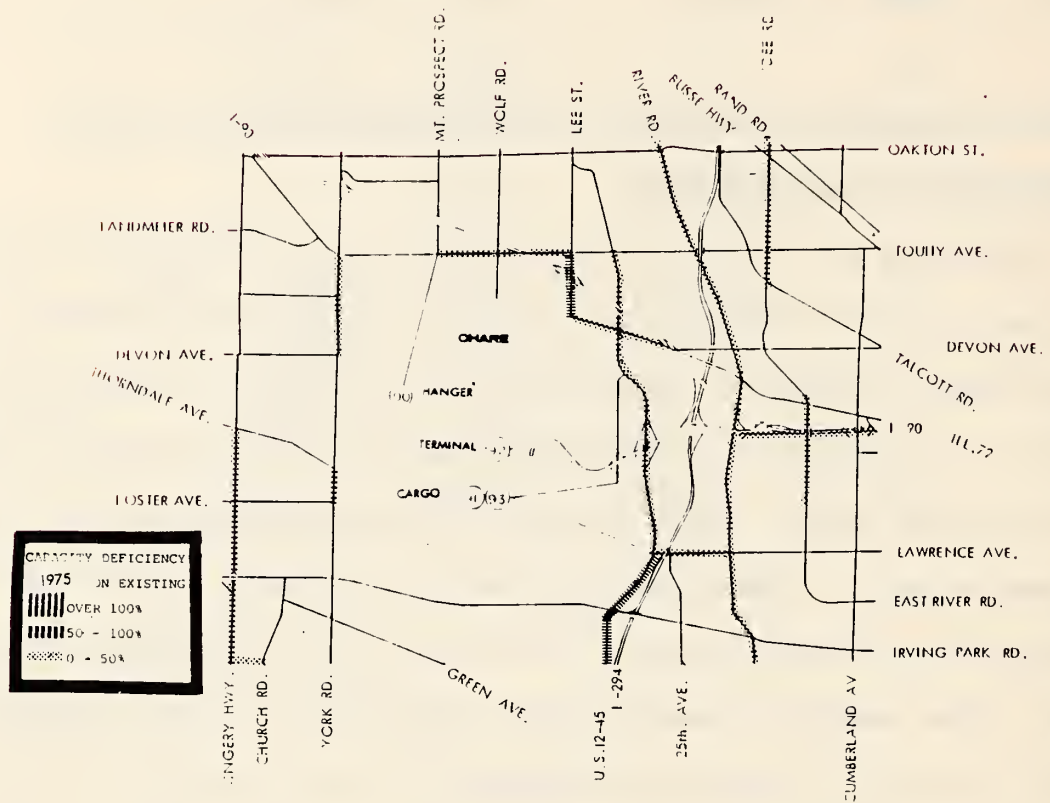
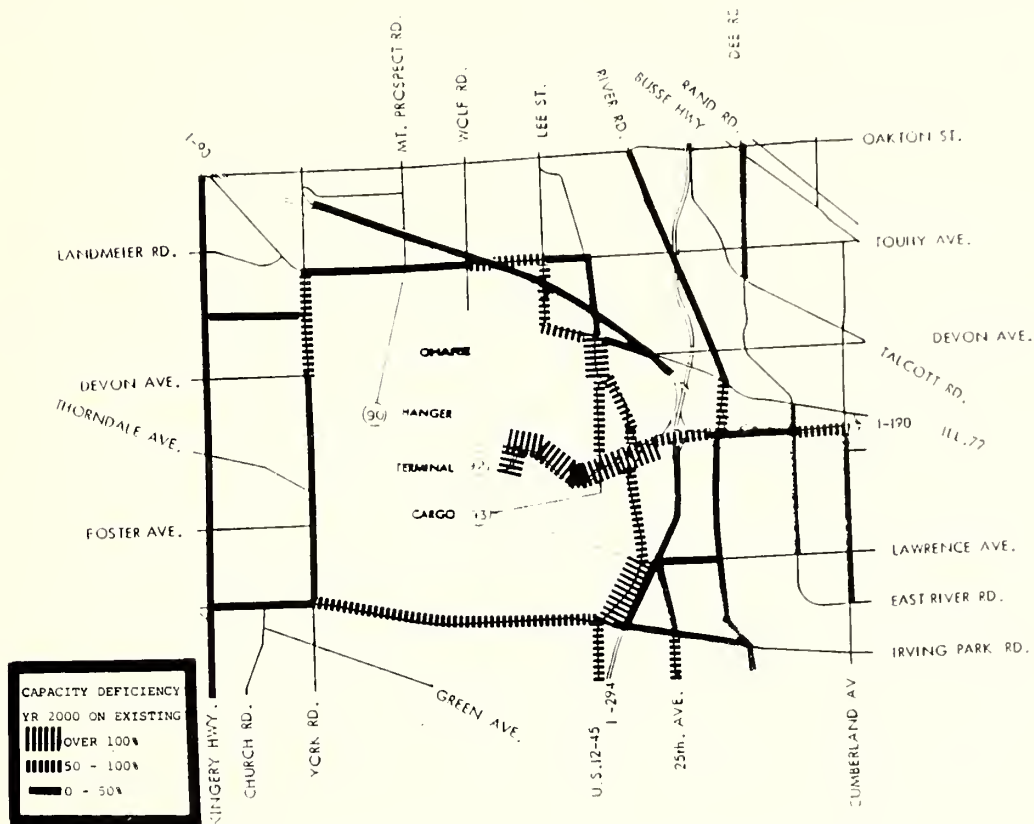


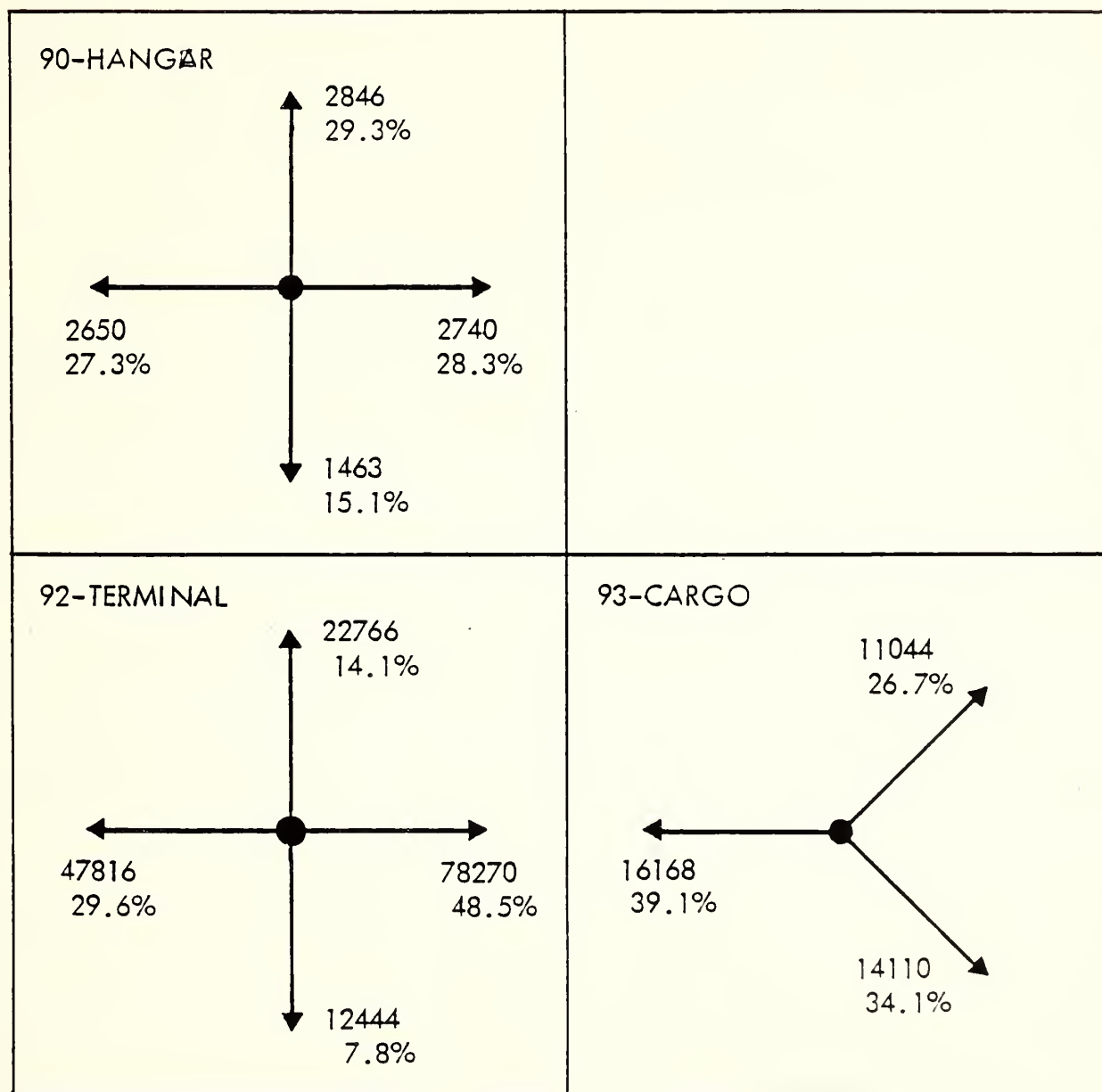
FIGURE 10: O'HARE ACCESS CAPACITY DEFICIENCY 2000 ON EXISTING



When year 2000 demands were loaded on the existing system, however, several significant problems developed on the facilities immediately adjacent to the airport. By the year 2000 traffic congestion on the airport entrance roadway and on sections of Mannheim Road will reach unacceptable levels. In addition, parts of Irving Park Road, York Road, Touhy Avenue, Lee Street, and Higgins Road also will have capacity deficiencies. These clearly are unacceptable conditions and indicate that the existing highway system serving O'Hare will not function satisfactorily under anticipated future traffic levels.

As the initial step in the development of alternatives a series of hypothetical directional links were coded into the existing highway network to allow access to all three airport areas from any direction (the hypothetical directional links are shown in Appendix Figure A2). These links do not represent real, or in some cases even feasible, alternatives. They were used solely to determine the directional distribution of access trips to O'Hare if the airport could be entered from any direction. The percentage distribution of all trips by direction resulting from the assignment of year 2000 trips on the existing network with the hypothetical links is shown in Figure 11. The percentages given in Figure 11 refer to O'Hare two-way volumes including auto and truck trips. This exercise confirmed the fact that a significant share of future trips to O'Hare will come from northern and western locations where access currently is most difficult. This result at least partly explains the deficiencies observed for 2000 trips on the existing system since some of this north and west oriented traffic must circle the field to get to the entrance roadway. This analysis was extremely useful in developing alternative access configurations for testing.

FIGURE 11: DIRECTIONAL DISTRIBUTION OHARE ACCESS TRIPS
YEAR 2000 OVER EXISTING HIGHWAY NETWORK



Four alternative networks were proposed by the advisory committee and these are summarized in Table 11. Each alternative is designed to provide improved access from the north and west where much of the future traffic growth is forecast. In addition some improvements on the eastern side of the airport are needed to remove bottlenecks there. Alternative A includes widening of the Kennedy Expressway west of the Tri-State as well as widening of Mannheim Road. These improvements correct identified deficiencies on the existing system and are also incorporated into Alternatives B and C. Alternative A provides direct access to O'Hare from the Northwest Tollway by means of a full interchange at Lee Street and an exclusive on-airport roadway. The present partial interchange at Lee Street only allows exit of west bound traffic from or entrance of east bound traffic to the tollway making its use for airport access infeasible. The northwestern access roadway would lead to a remote parking lot served by a high speed people mover system.

This people mover system is an integral element of all the alternatives. Such a system is required to allow access to O'Hare other than that provided by the present airport entrance roadway. This system is envisioned to operate at 4 to 5 minute intervals providing a rapid link from remote locations to the central core complex. Some of the early master plan concepts considered at this point in the study contemplated a system of satellite concourses in addition to the remote parking lots. These concepts required a much more extensive people mover system than that required solely for ground access. For the purposes of the access analysis it was assumed that the time to get to the gates from both the central and remote parking locations was comparable. This assumption meant that whatever time advantage the central garage had because of its proximity to the terminals was lost due to the congestion of

TABLE 11: O'HARE ACCESS STUDY ALTERNATIVE TEST HIGHWAY NETWORKS

ALTERNATIVE A

1. Add lanes to Kennedy Expressway west of Tri-State.
2. Add lanes to Mannheim Road.
3. Full Lee Street/Northwest Tollway interchange.
4. Parallel airport feeder roadway south of Higgins Road.
5. Remote northeast parking lot with people mover.
6. Cargo area remains in present location.

ALTERNATIVE B

1. Alternative A improvements.
2. Thorndale Avenue arterial extension east to Irving Park Road.
3. Remote western parking lot with people mover.
4. Cargo area split, half of activity relocated to southwest corner with access to Thorndale Avenue.

ALTERNATIVE C

1. Alternative A improvements.
2. Alternative B improvements.
3. Full York Road/Northwest Tollway interchange.
4. York Road improvements.
5. Cargo area split, half of activity relocated to southwest corner with access to Thorndale Avenue.

ALTERNATIVE D

1. Elgin-O'Hare expressway.
2. Full York Road/Northwest Tollway interchange.
3. York Road and Irving Park Road improvements.
4. Remote western parking lot with people mover and direct connection to Elgin- O'Hare.
5. Cargo area split, half of activity relocated to southwest corner with access to Elgin-O'Hare.

the internal circulation roadway.

Direct western access is provided in Alternative B via a remote western parking lot accessible from York Road and connected to the central core complex by people mover. Alternative B also includes the extension of Thorndale Avenue to Irving Park Road to circumvent the York/Irving Park intersection bottleneck. Finally, the cargo area is split in each of the western access alternatives with half its' activity shifted to a new cargo center located in the southwest corner of the field. The cargo center would be accessible by the Thorndale Avenue extension in Alternatives B and C.

Alternative C is nearly identical to B with the addition of a full interchange with the Northwest Tollway at York Road. Some capacity improvements along York Road are also included in Alternative C. Alternative D also provides direct western access with a remote parking lot and people mover. However, the arterial access supplied to this western lot in Alternatives B and C is replaced by a limited access expressway. The Elgin-O'Hare Expressway is recommended in the Year 2000 Plan. This four to six lane facility would run from Elgin in Kane county to Irving Park Road just south of the airport. As in Alternatives B and C, half the cargo activity is relocated to the southwestern corner of the field with access to the Elgin-O'Hare Expressway.

Evaluation of the Alternatives

The same capacity deficiency technique employed in the analysis of the existing system was used to evaluate each alternative. The year 2000 triptables were loaded on to Alternatives A, B, C, and D. The results are shown in summary form in Figures 12, 13, 14, and 15 respectively (Appendix

Figures A3, A5, A6, and A6 give Year 2000 assignment volumes on each alternative. Appendix Figure A4 gives the O'Hare bound share of volume for Year 2000 on Alternative A).

As seen in Figure 12 the additional access provided by the Northwest Tollway/Lee Street interchange and the remote northeastern parking/people mover combination is sufficiently attractive to eliminate the congestion on the airport entrance roadway observed under year 2000 conditions on the existing system. However, this alternative does introduce capacity problems along Lee Street as it feeds the on-airport roadway serving the northeast lot.

The results for Alternative B shown in Figure 13 also indicate that provision of a second airport access choice, in this case the western lot/people mover combination, can indeed eliminate the need for the very costly expansion of the current airport entrance roadway. In addition, by moving significant airport access traffic to the western side of the airport the congestion on nearly all of the eastern arterials can be greatly reduced. But, with only arterial access provided to the remote western lot in Alternative B the traffic conditions along York Road, Irving Park Road, and Thorndale Avenue are likely to deteriorate. Because of the tunneling required to construct the western people mover link this is a high capital cost option. Though capital costs were not examined in the access study they obviously must be considered in developing the recommended plan.

The addition of a York Road/Northwest Tollway interchange and limited capacity expansion along York Road in Alternative C does not significantly improve the traffic flow on these west-side arterials as shown in Figure 14. Much of this western arterial congestion is due to the attractive nature of direct western access to O'Hare. Some part of it can also be attributed to

FIGURE 12: O'HARE ACCESS CAPACITY DEFICIENCY 2000 ON ALTERNATIVE A

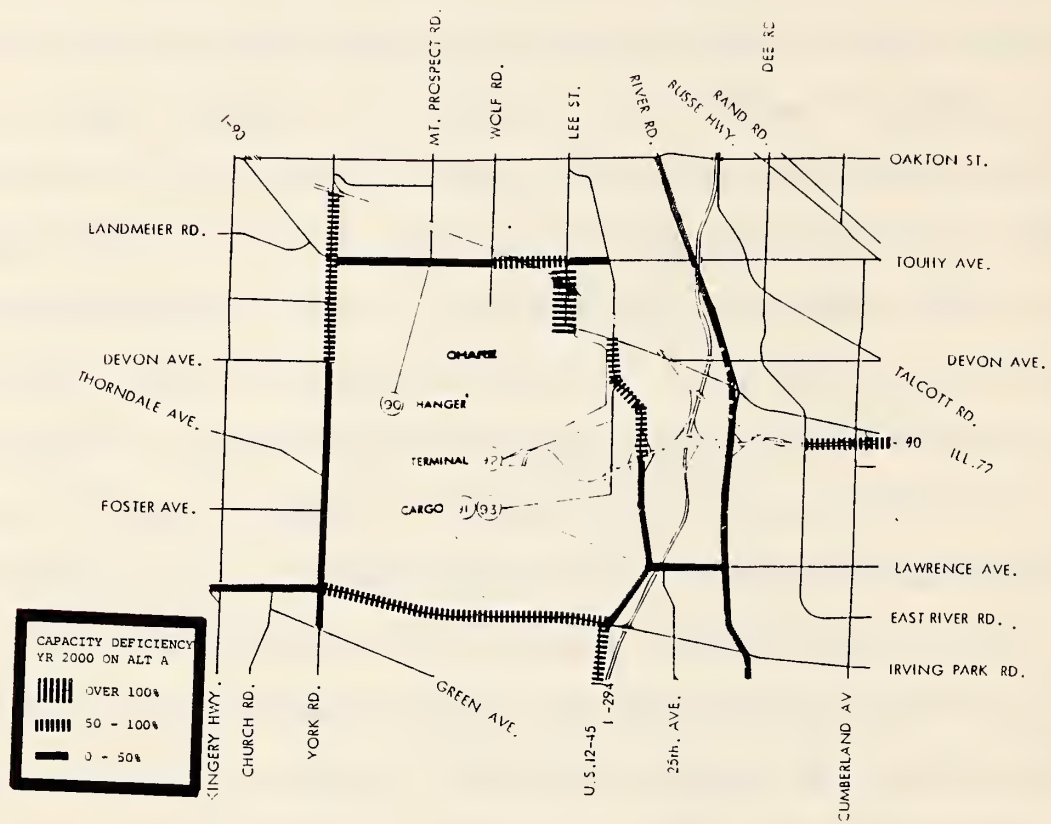


FIGURE 13: O'HARE ACCESS CAPACITY DEFICIENCY 2000 ON ALTERNATIVE B

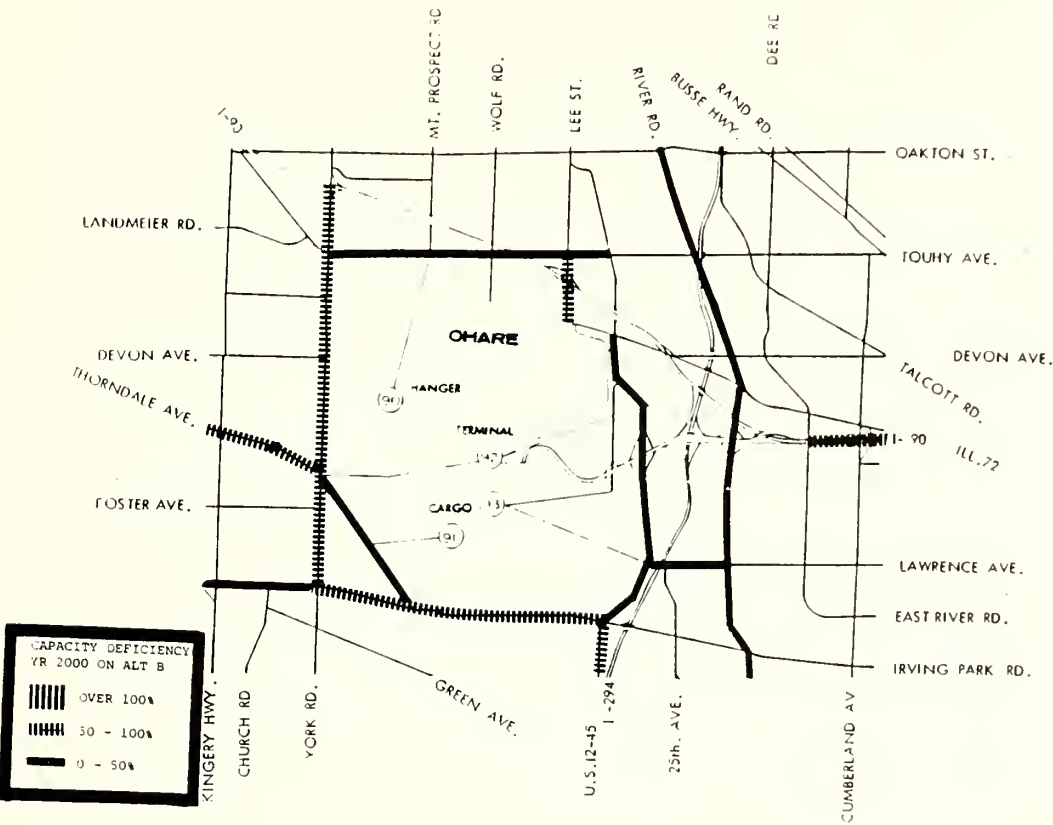


FIGURE 14: O'HARE ACCESS CAPACITY DEFICIENCY 2000 ON ALTERNATIVE C

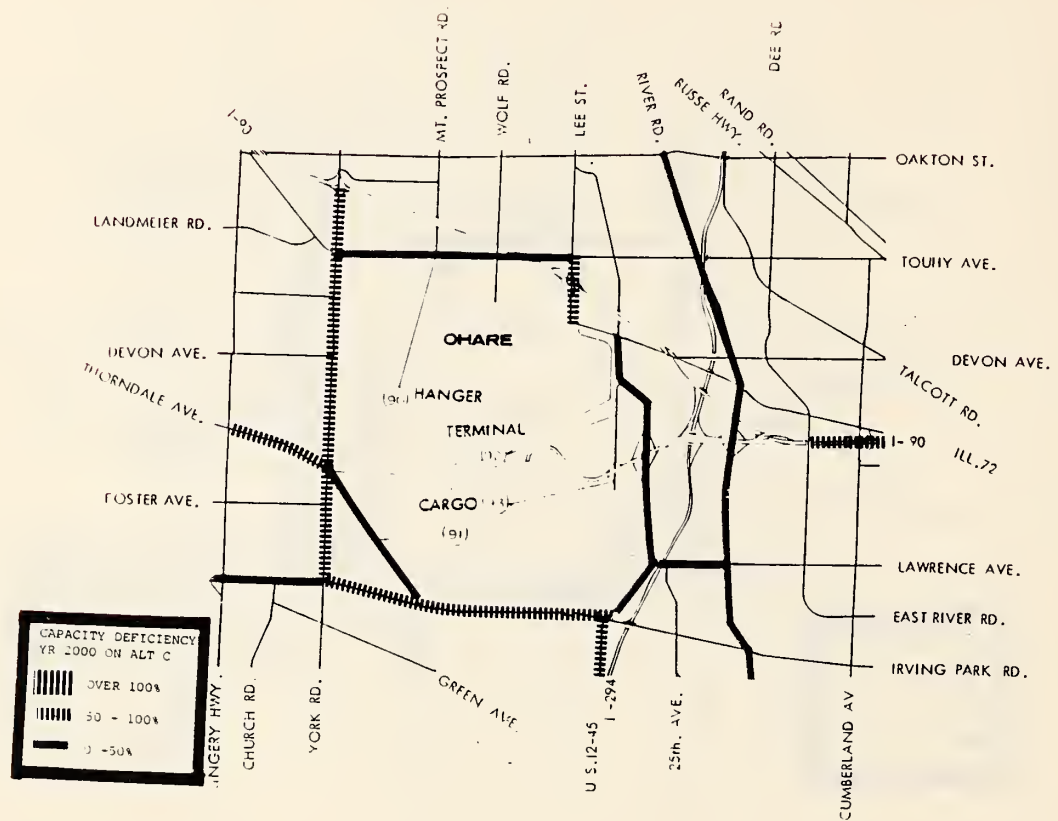
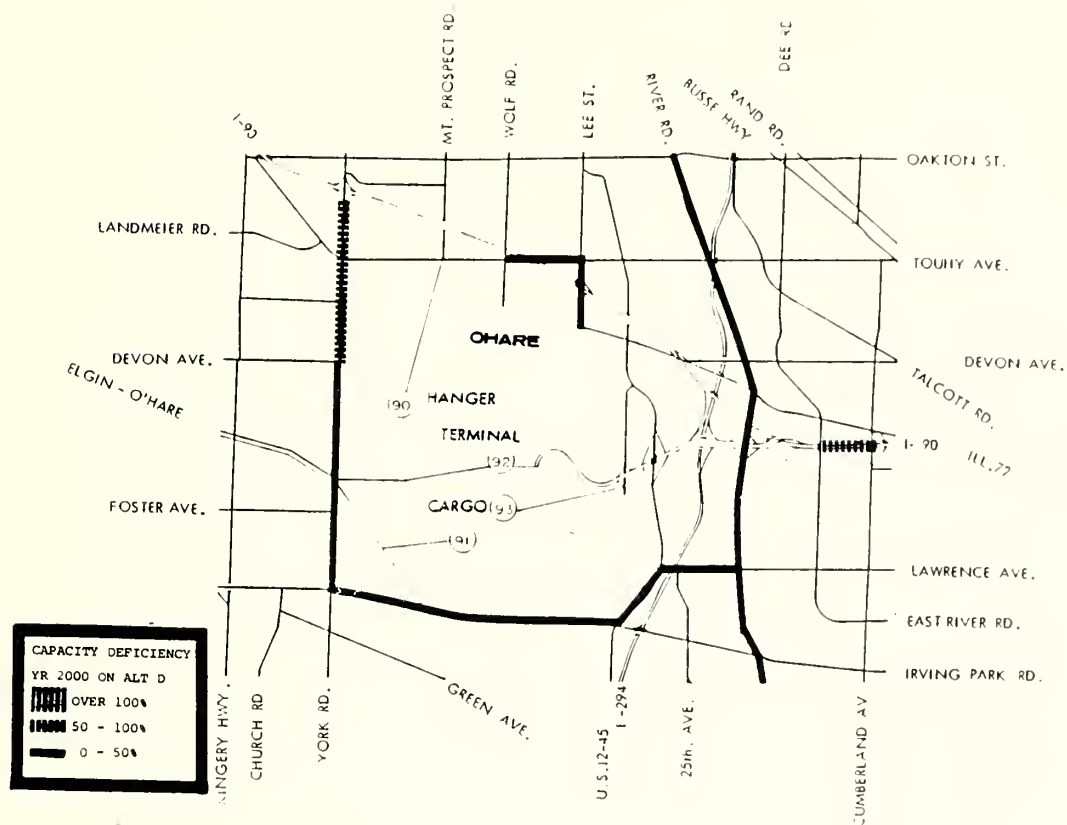


FIGURE 15: O'HARE ACCESS CAPACITY DEFICIENCY 2000 ON ALTERNATIVE D



the large volume of truck traffic shifted to this area with the relocated cargo facilities.

Finally, the capacity deficiency map for Alternative D given in Figure 15 indicates that the proposed Elgin-O'Hare Expressway will reduce much of this western side arterial congestion. Alternative D includes a direct connection from the expressway to the remote western parking lot. Under this alternative western ground access service characteristics are of comparable quality as that provided by the Kennedy Expressway and the entrance roadway on the east side of O'Hare.

The Recommended O'Hare Development Program

The O'Hare master planning process involved inventory and analysis of the existing facilities, determination of the economic impact of the airport, forecasts of future aviation demand, and development and evaluation of a series of airfield concepts (21), (22), (23). The analysis of the ground access study was used in combination with studies of the airside and landside systems to evaluate these airport concepts.

These studies lead to the preparation of a recommended O'Hare development program (25), (26), (27). This development program was divided into three phases. The first phase is to be constructed by 1990. An environmental assessment (24) was prepared for Phase I and the FAA has issued a finding of no significant impact (14) at least partly clearing the way for implementation. A second obstacle to implementation was removed when the City of Chicago agreed with the surrounding municipalities to pursue noise reduction strategies including establishment of a noise complaint and monitoring office (4). In response the suburban municipalities agreed to drop

a pending federal court suit which would have required the city to prepare a full scale environmental impact statement.

Figure 16 summarizes the recommended 1990 O'Hare development program resulting from the master plan process. The compact central core concept which provides aircraft access from all runways into a distribution center is preserved in the plan. The cargo facilities and the ground access system are reorganized to obtain added capacity. A new Terminal 1 on the site of the present international terminal and a new concourse L in Terminal 3 will supply an additional 30 gates (Figure 17). New international and commuter terminal facilities are planned on the present cargo site (Figure 18). These new terminals would be connected to the central core by a people mover. This people mover will follow the terminal roadway connecting all the terminal buildings and facilitating passenger movements between terminals. The cargo facilities would be completely relocated to the southwest corner of the airport in a new "cargo city" (Figure 19).

The recommended ground access system reflects the findings of the access study concerning the need for north and northwest access to the airport. The plan calls for construction of a new interchange with the Northwest Tollway at Wolf Road. This partial interchange would consist of ramps providing outbound entrance to and inbound exit from the tollway onto an exclusive on-airport roadway leading to a remote northeastern parking lot. The international and commuter terminal people mover line would extend to the northeast lot providing access from the lot to the central core. The access system of the recommended plan is similar to the tested Alternative A and is expected to function much like that alternative. This plan obviously can not provide the same service for western and southwestern oriented trips as would direct

FIGURE 16: O'HARE AIRPORT 1990 DEVELOPMENT PROGRAM

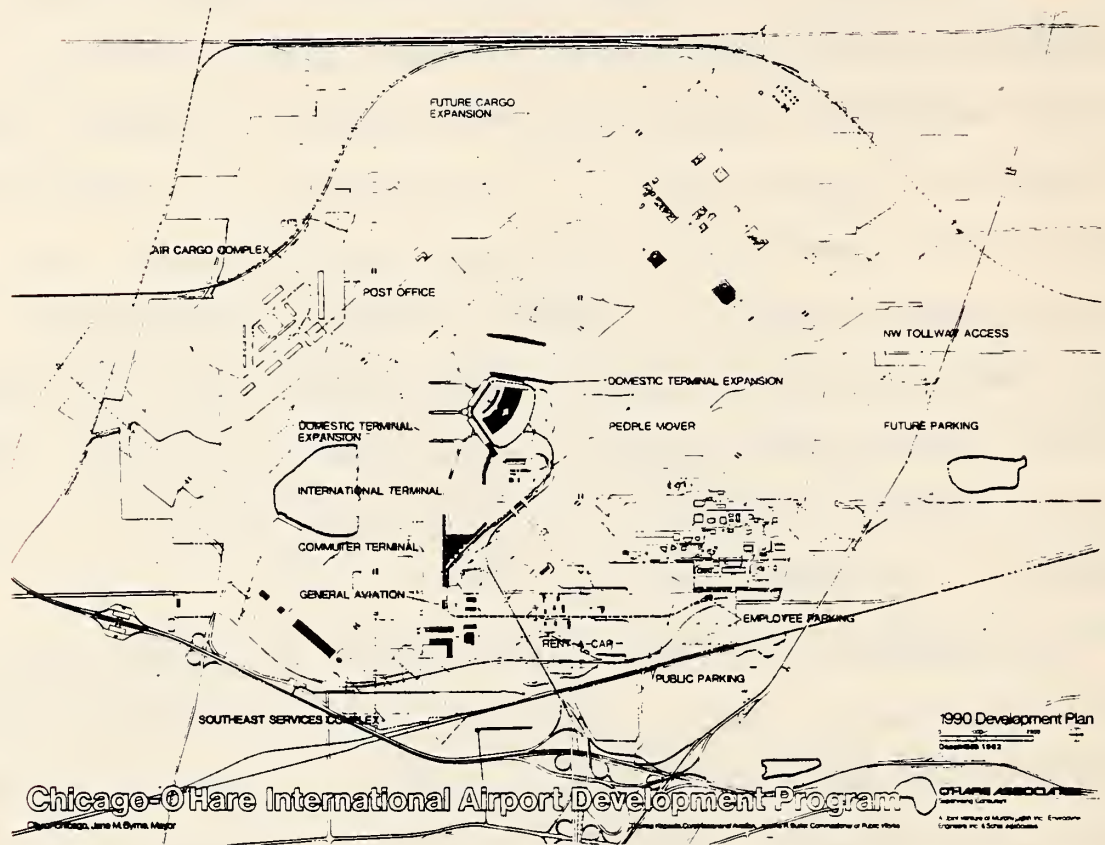
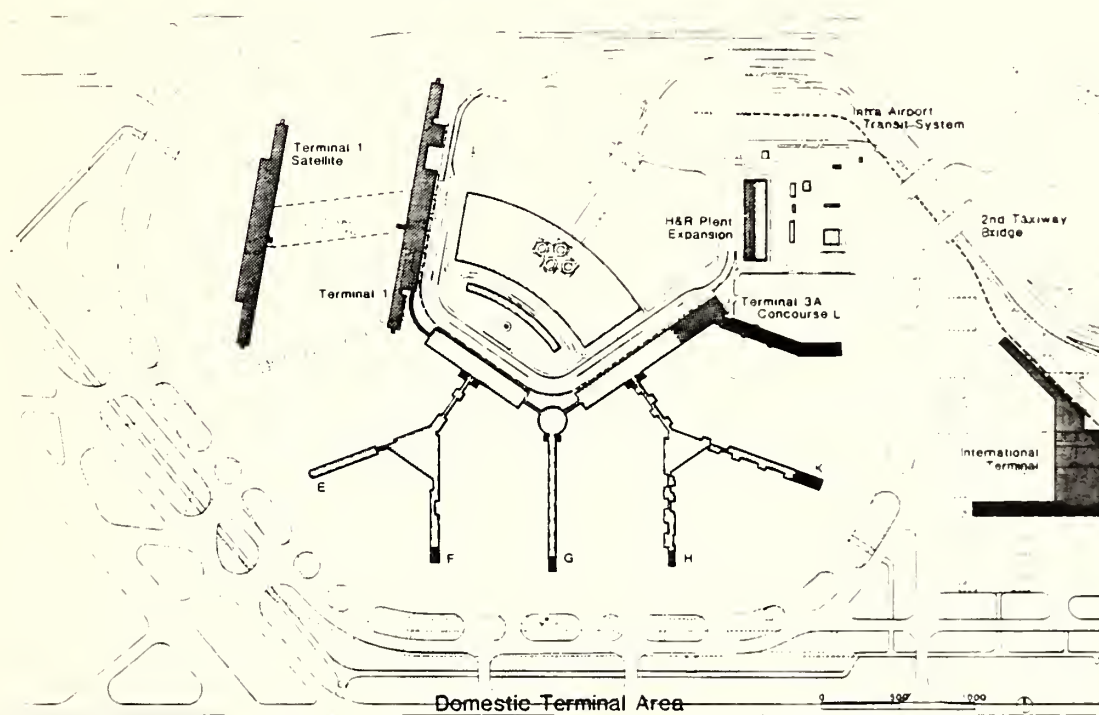


FIGURE 17: O'HARE AIRPORT 1990 DEVELOPMENT PROGRAM DOMESTIC
TERMINAL AREA



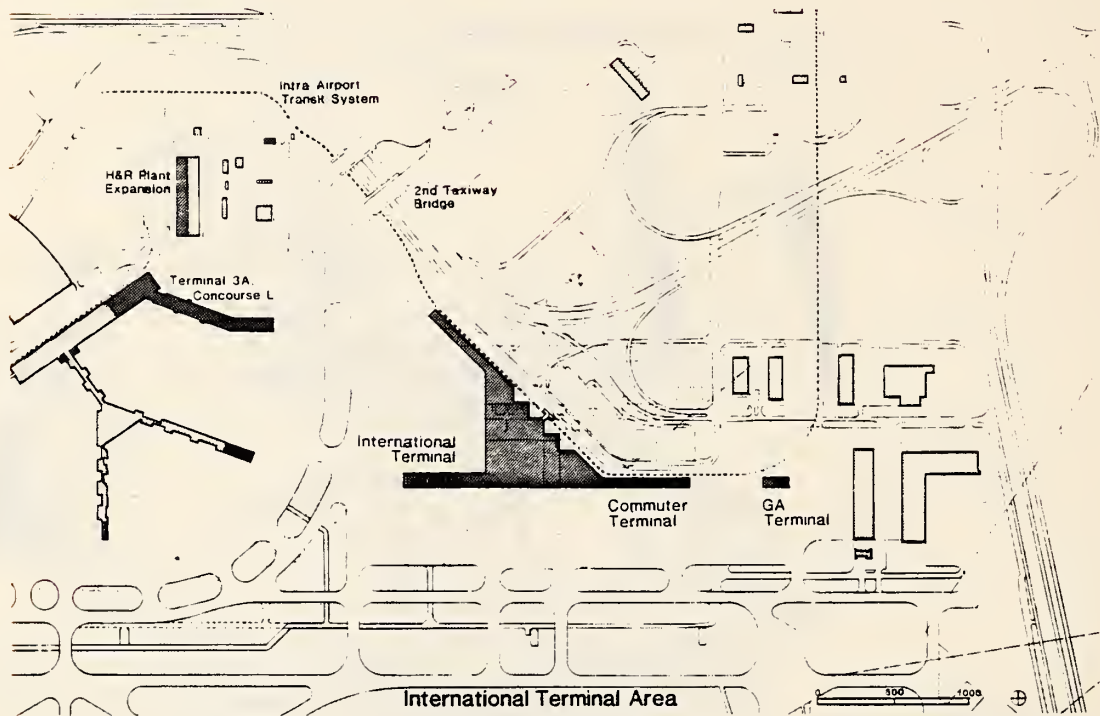
Chicago-O'Hare International Airport Development Program

City of Chicago, Jane M. Byrne, Mayor

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FIGURE 18: O'HARE AIRPORT 1990 DEVELOPMENT PROGRAM INTERNATIONAL
TERMINAL AREA

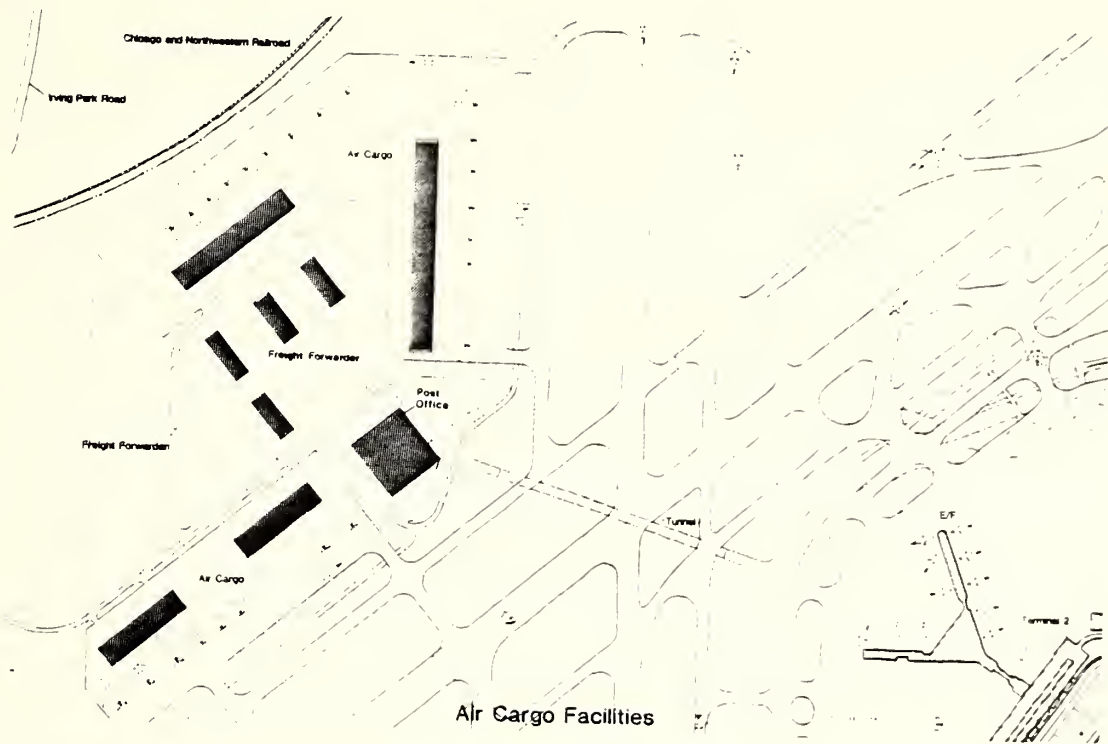


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FIGURE 19: O'HARE AIRPORT 1990 DEVELOPMENT PROGRAM AIR CARGO FACILITIES



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western access. But, it does represent an improvement over the exclusively eastern access provided by the present system and a compromise in terms of the cost of rebuilding O'Hare's access system.

Another feature of the plan is the exclusive loop roadway serving the new international and commuter terminals. This new roadway will allow segregation of the domestic and international ground traffic and should eliminate the need for all traffic to circle the complete terminal complex roadway thereby reducing congestion.

While the recommended plan does not exactly duplicate any of the alternatives examined in the access study it does respond to the major findings of the analysis. The recommended plan represents a compromise between cost and performance which should function efficiently in the next decade as O'Hare seeks to continue and to expand its' role as a major aviation hub of the nation.

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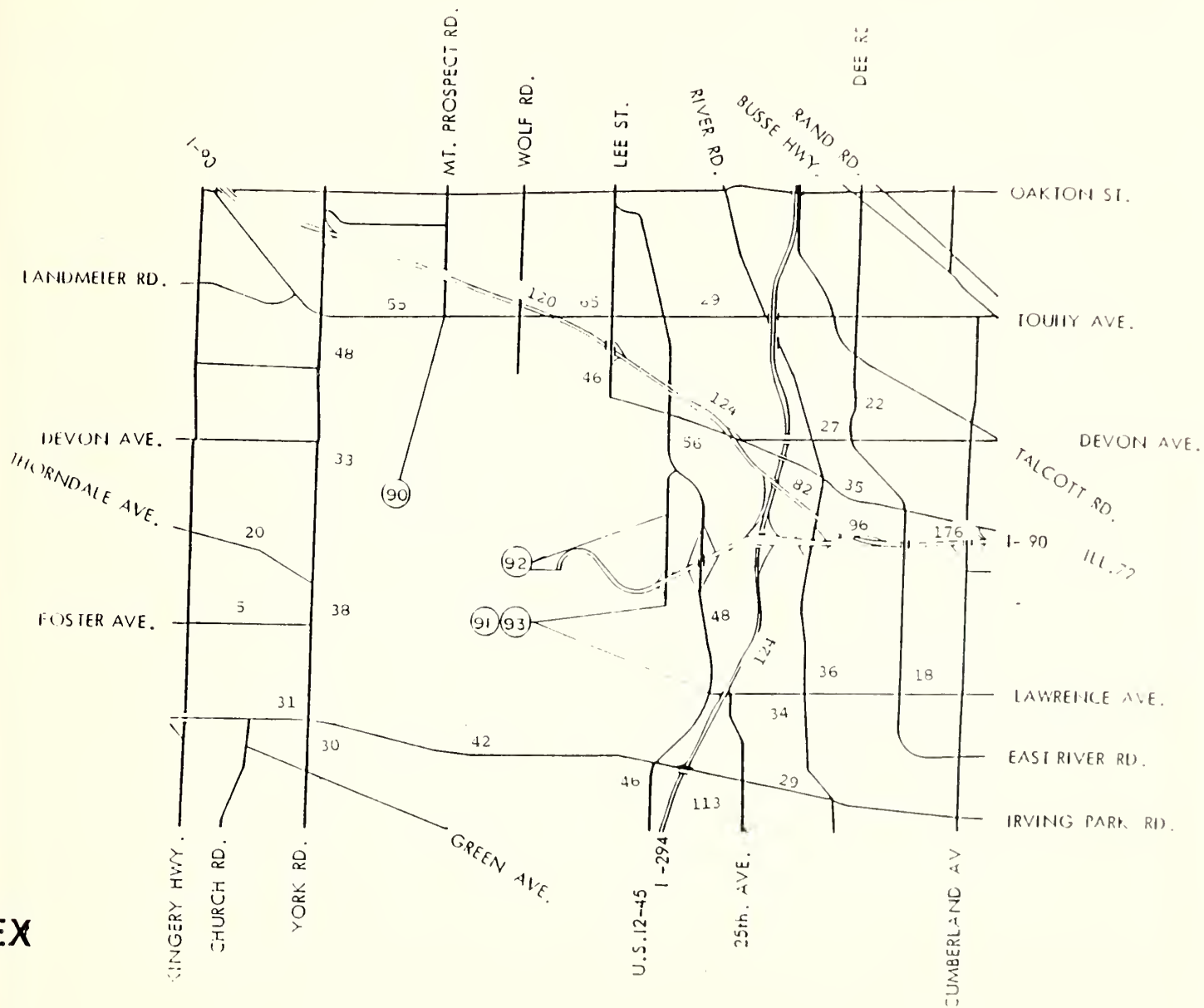
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APPENDIX

FIGURE A1: YEAR 2000 VOLUMES OVER EXISTING



Note: Assignment volumes are given in thousands and are two-way average daily volumes.

FIGURE A2: HYPOTHETICAL DIRECTIONAL LINKS

HYPOTHETICAL LINKS

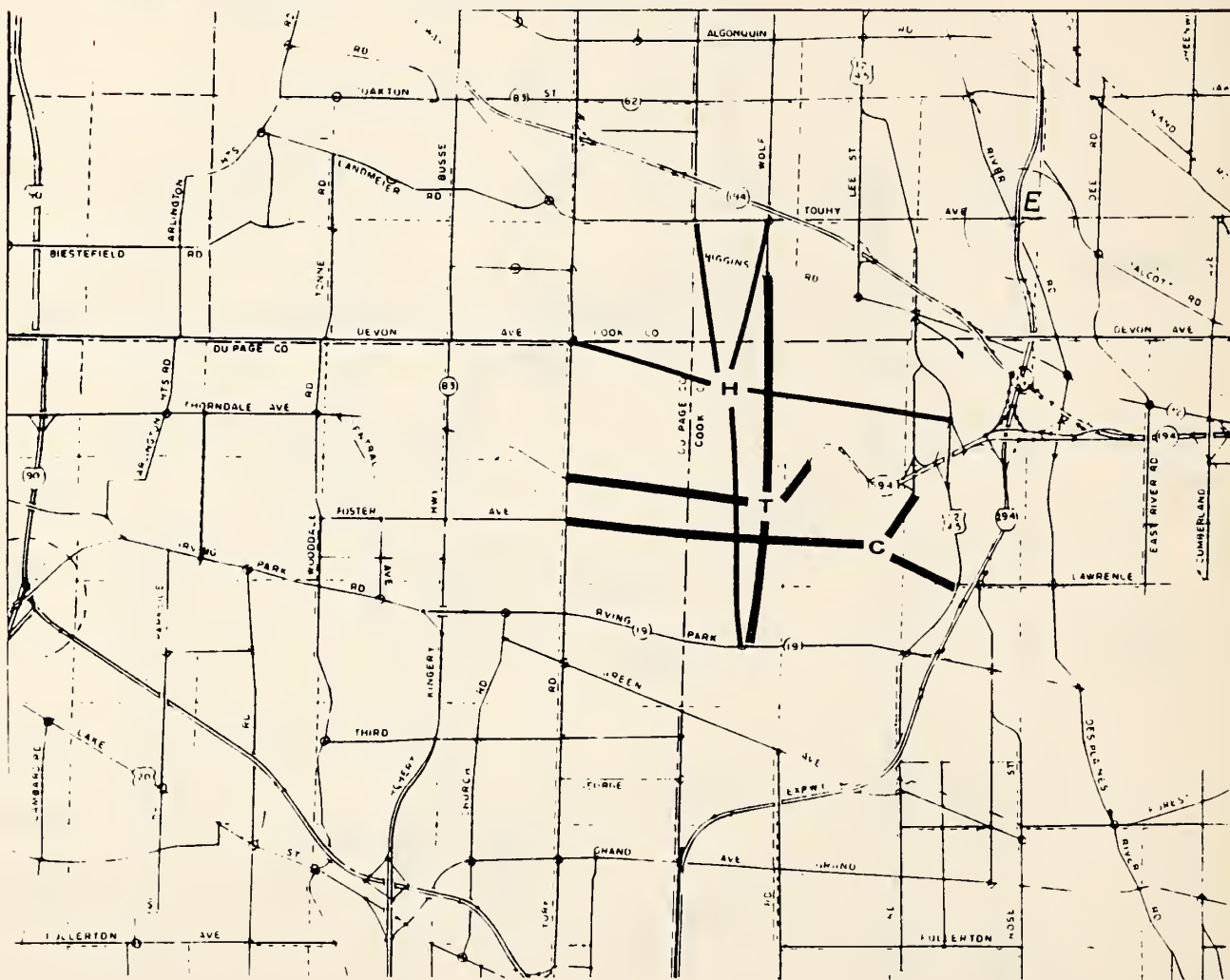
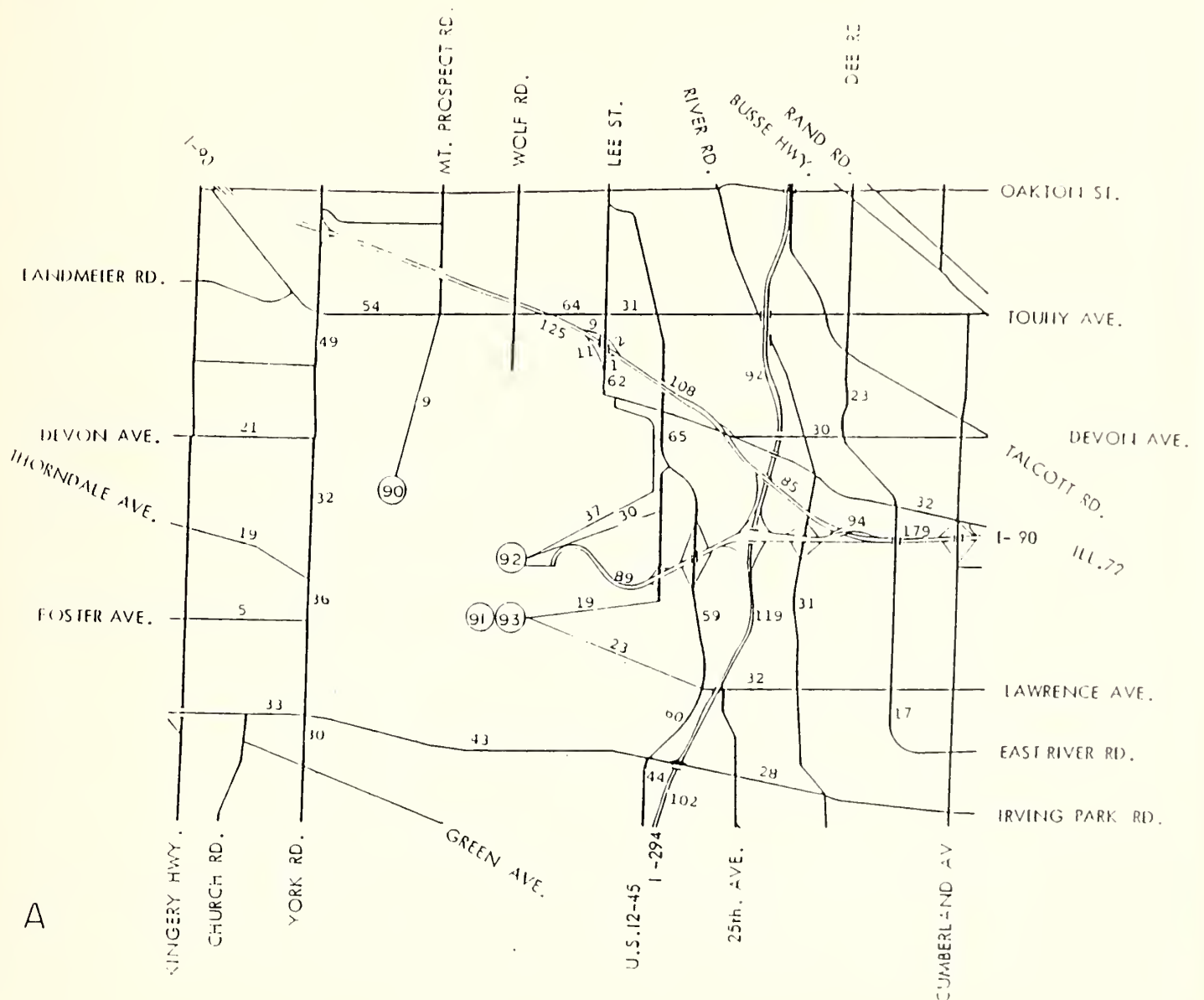


FIGURE A3: YEAR 2000 VOLUMES OVER ALTERNATIVE A



Note: Assignment volumes are given in thousands and are two-way average daily volumes.

OHARE SHARE (percent)
SELECTED LINK VOLUMES

2000 ON EXISTING NETWORK
2000 ON TEST NETWORK -- A

B

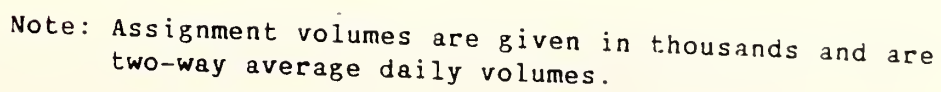
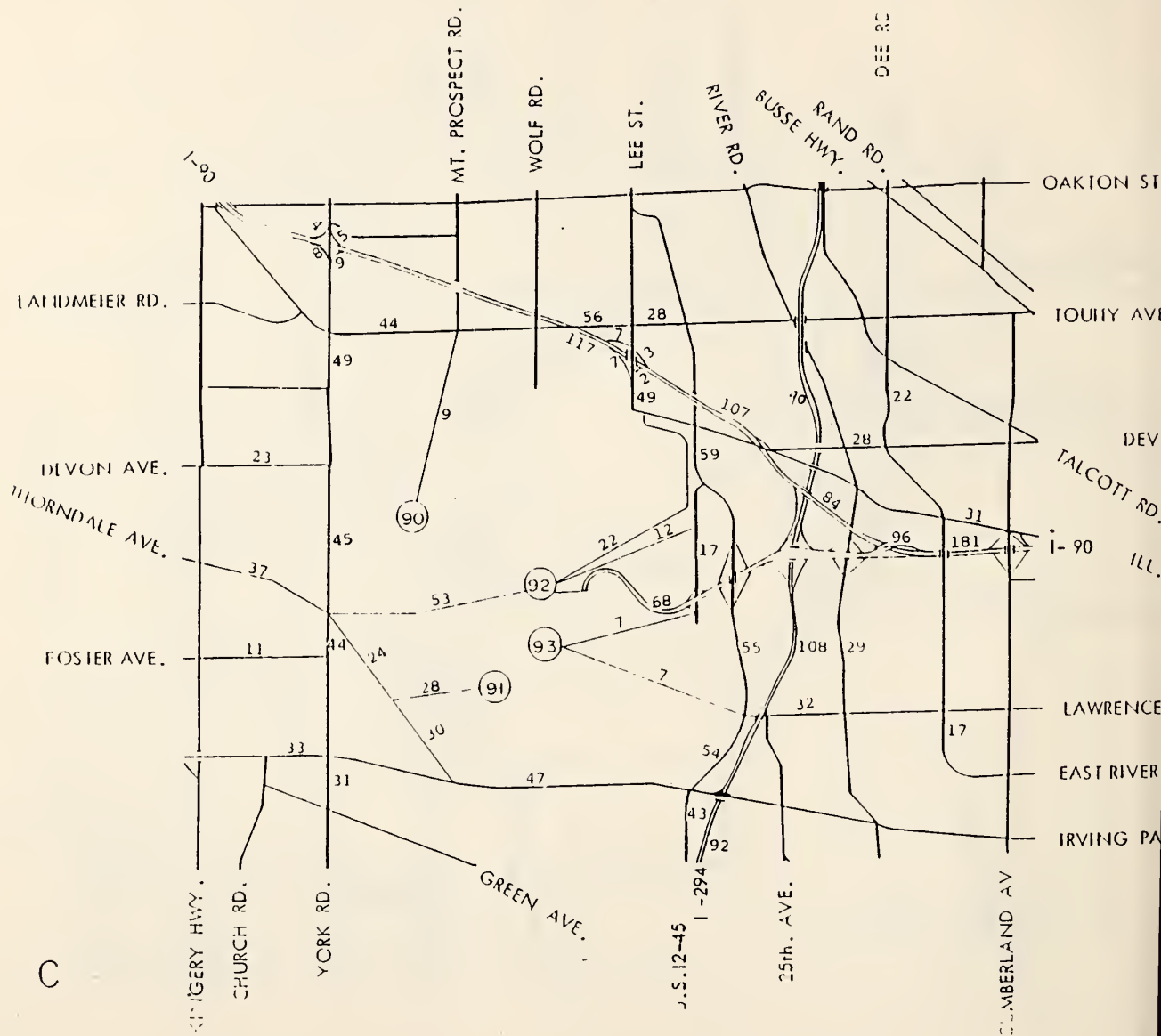
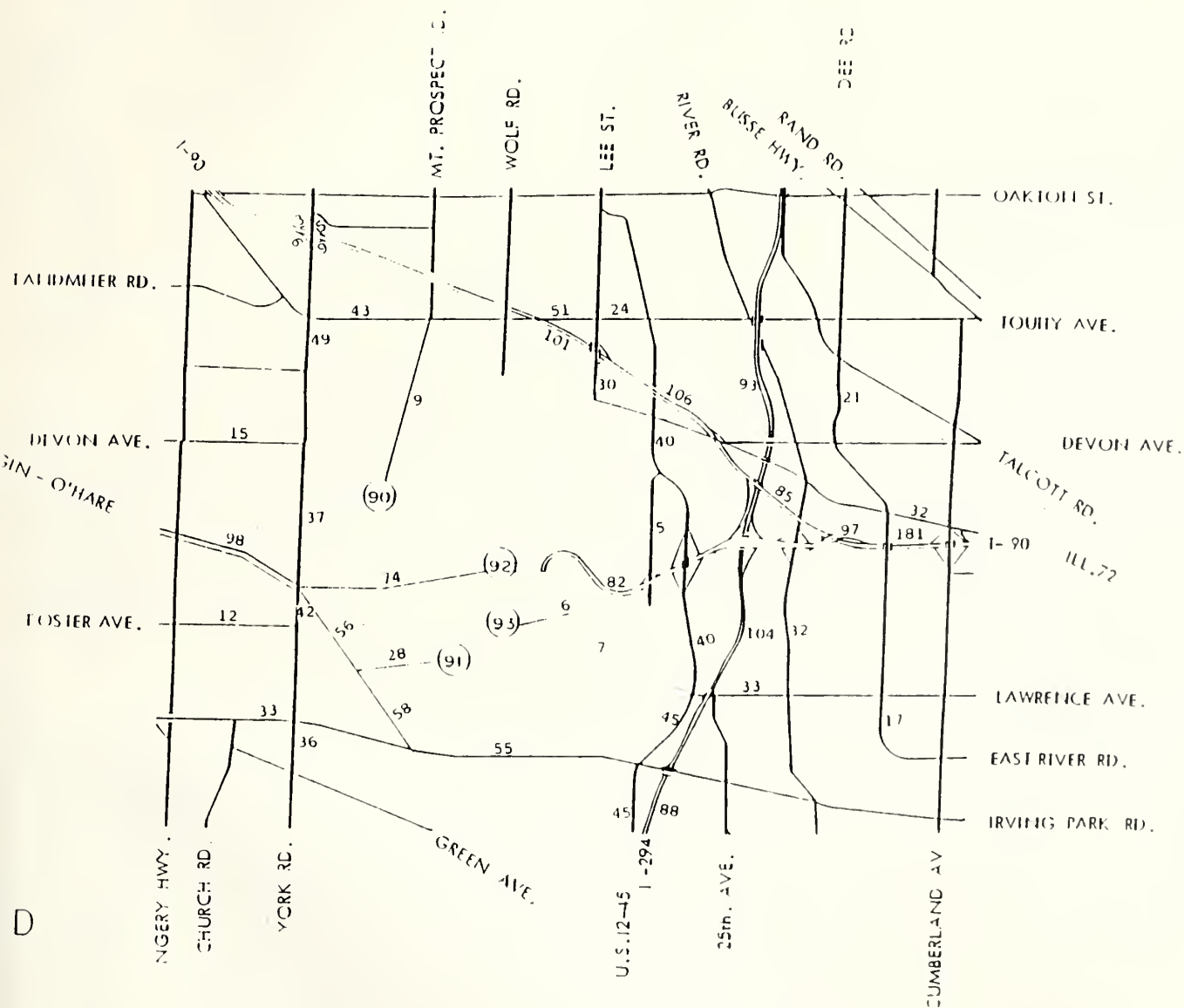


FIGURE A6: YEAR 2000 VOLUMES OVER ALTERNATIVE C



Note: Assignment volumes are given in thousands and are two-way average daily volumes.

FIGURE A7: YEAR 2000 VOLUMES OVER ALTERNATIVE D



Note: Assignment volumes are given in thousands and are two-way average daily volumes.



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